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The Transandean Railway from Arica, Chile, to La Paz, Bolivia

By G. H. Sawyer*

On May 13, 1913, a 459-km. (144 mi.) meter-gage railway, with a 24-mi. rack section, was opened between Arica, in Chile and on the Pacific Ocean, and LaPaz in Bolivia, beyond the Andes and some 11,800 ft. above sea-level. The line is through virgin country and is by far the shortest route from the coast to the Bolivian interior, although La Paz was already connected by two longer lines to Pacific ports. In addition to rising to about as high an elevation as any railway in the world,† this new line has the distinction of containing one of the longest stretches of rack road in existence. For these reasons a description of its location and construction details should be of interest to American engineers.

Fig. 1. Arica, Chile, on the Pacific

Fig. 2. LaPaz, Bolivia, from the Alto of LaPaz. Elevation 11,800 Ft.

Figs. 1 and 2. The Termini of the Arica-LaPaz Ry.

(From photographs furnished by the Pan-American Union, Washington, D. C.)

History

The railway from Arica to the Alto of La Paz, a height of land outside of and about 1500 ft. above the town of La Paz, was constructed by the Chilean Government in accordance with the terms of the treaty of Peace and Friendship between this Government and Bolivia, signed Oct. 20, 1904. It was agreed that the Chilean Government should contract for the construction of a line between the port of Arica and the Alto of La Paz within one year of the date of the ratification of the treaty, and in March, 1906, the contract was let to the Syndicate of Public Works for the lump sum of £2,152,000, the work to be completed within four years.

In accordance with this contract the Syndicate was to have completed the first section of 65 km. within one year, and failing to do this on account of lack of funds, labor, etc., the contract was rescinded in October, 1907, and the work turned over to the Fiscal Inspector, Don Benjamin Vivanco, who in turn delivered the line to Don Manuel Ossa, who continued the construction by administration until June, 1909.

The contract for the completion of the railway was made with Sir John Jackson (Chile) Ltd., an English engineering firm and was signed on May 1, 1909. The work was to be completed within three years from this date, and for the lump sum of £2,750,000. From this amount was deducted £300,000 to cover the cost of the work already executed, and the value of materials then on hand which had been acquired for the construction. Up to this time the track was laid and ballasted as far as km. 41 and the earthwork had been completed more or less to km. 70, about 40 km. of line having been abandoned on account of a change in route suggested by Manuel Ossa and under whose administration the new surveys were made.

General Features

The total length of line, which is of meter gage, is 439 km., 206.5 km. in Chile and 232.5 km. in Bolivia, and the maximum elevation reached is 4257 m. (13,970

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*Arica, Chile.

†The record heights attained by the railways of South America, which are the highest in the world, are as follows: —Ed. "Eng. News."

Roads in operation:	
Antofogasta & Bolivia Ry.	13,000 ft.
Oroya Ry., Peru	15,666 ft.
Peruvian Southern Ry.	14,665 ft.
Arica-La Paz	13,970 ft.
Roads under construction:	
Antofogasta & Bolivia Ry.:	
Ollague-Collahuasi branch	15,809 ft.
Rio Mulato-Potosi branch	16,000 ft.

FIG. 3. THE ARICA-LA PAZ RY., A METER-GAGE ROAD WITH 24 MI. OF RACK

ft.) above sea-level (Figs. 3 and 4). Leaving Arica the line runs almost directly north for about 10 km., where it swings to the northeast, following the Lluta Valley some 30 km., then developing back on the slopes and finally reaching the foot of the rack at km. 70. From this point to km. 110.5 the line passes through very broken and barren country and rises 2190 m. (7200 ft.). On the Pacific slope of the Andes rain never falls and no vegetation of any kind exists except in the valleys. From km. 110 to the Bolivian frontier the line traverses a plateau, varying from 3700 to 4260 m. (12,160-14,000 ft.) above sea-level and almost void of vegetation (Fig. 8). Between the frontier and the Alto of La Paz, it follows the valley of the Mauri River and the Colorado where there is some agriculture, and where sufficient wild pasture exists to raise sheep and llamas.

The chief sources of traffic will be the extensive sulphur deposits of Tacora near km. 170, the large copper deposits of Corocoro, to which a branch has been constructed (8 km. in length) and the numerous smaller copper mines in the Bolivian section. Also it is expected that the road will get a large percentage of the traffic to and from La Paz. From the various estimates of the probable traffic it may be assumed that for the first few years before the development of the Bolivian Railway systems the total amount of tonnage will not exceed 100,000 tons.

There are two other railways running from the coast to La Paz with which the new line will compete. The Mollendo-Arequipa Ry. is a standard-gage line, owned by the Peruvian Corporation operating in connection with small steamers on Lake Titicaca. The length of this line is 844 km. The Antofogasto Railway Co. is a 30-in. gage, owned by an English company, and having a total length of 1157 km.

GRADES AND CURVES

The maximum grades on the adhesion portion of the line are 3% and on the rack section 6%, none of which are compensated for curvature. The maximum curves allowed on the adhesion section are of 100-m. radius, and on the rack section of 140-m. radius. No transition curves were used.

RACK

Perhaps the feature which will be of most interest to engineers is the extreme length of rack. As will be noted on the profile (Fig. 4) the rack begins at 70.7 km. and ends at 110.5 km., between these points there being several stretches of lighter gradients to provide for passing sidings, coaling and watering stations. The total length of the rack is 38.742 km. (24.1 mi.), of which 2.8 km. is on gradients less than 3%, the maximum allowed on adhesion sections. The object of this is to make as few as possible breaks necessitating a change in velocity of trains, and to reduce to a minimum the number of entrance tongues.

The system which has been adopted is the Abt, consisting of two rack bars 27 mm. in thickness and 125 mm. in extreme depth. These bars are made in sections 1.80 m. in length and are bolted to cast-iron chains which are in turn bolted to steel-trough ties 2 m. in length (Fig. 5). The ties are spaced 900 mm. except at the joints where an extra tie is added to form a suspended joint. The sleepers are bent so that the vertical axes of the rails make an angle of 1:20 with the vertical. The rail fastenings consist of 19-mm. bolts and clips so designed that certain combinations will allow the extra width necessary on curves.

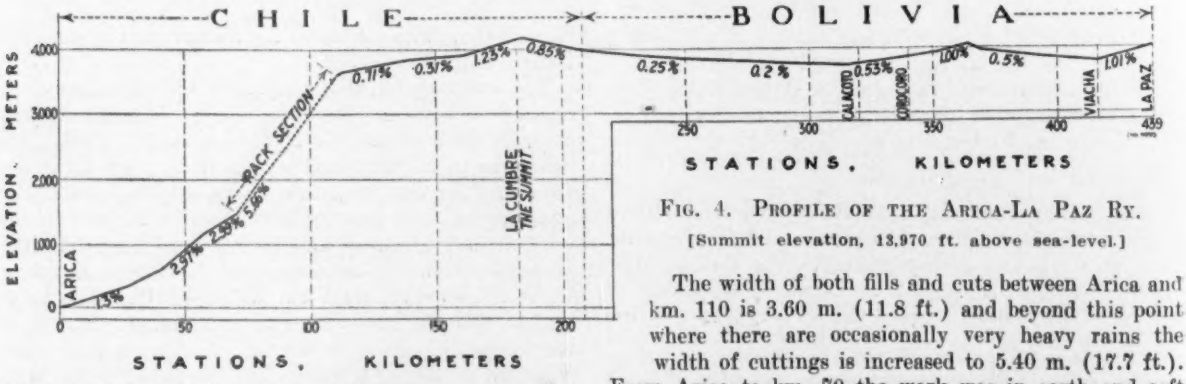


FIG. 4. PROFILE OF THE ARICA-LA PAZ RY.
[Summit elevation, 13,970 ft. above sea-level.]

The width of both fills and cuts between Arica and km. 110 is 3.60 m. (11.8 ft.) and beyond this point where there are occasionally very heavy rains the width of cuttings is increased to 5.40 m. (17.7 ft.). From Arica to km. 70 the work was in earth and soft volcanic rock, and comparatively easy. Between km. 70 and km. 110 the earthwork was very heavy, the first few kilometers being in soft volcanic rock and the remainder in granite. Between km. 110 and the Alto of La Paz with the exception of a few isolated cuts the earthwork was very light. No excavating machinery was used owing to the scarcity of water and difficulties of transportation. Nar-

row-gage portable track and 0.75-cu.m. dump cars were used extensively.

The work was generally let to small gangs of the laborers in stations which proved to be far more economical than work by administration. The common laborers in Chile are paid from 5 to 6 pesos per day, with exchange

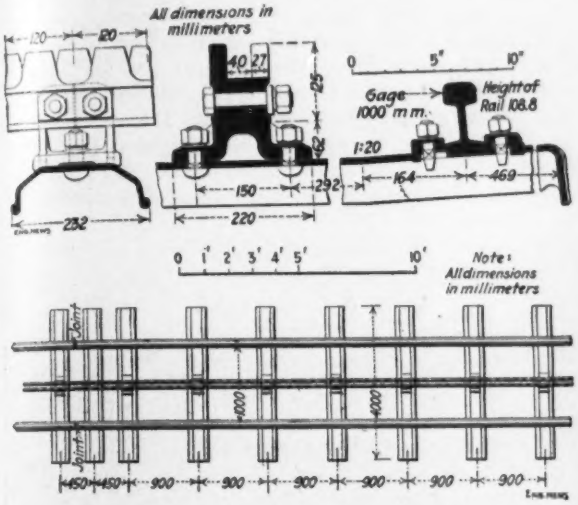


FIG. 5. DETAILS OF THE ABT RACK SYSTEM USED ON THE ARICA-LA PAZ RY.

varying from 10 to 12d. The work between km. 41 and km. 110 was specially difficult, owing to the absence of water, which was transported on pack animals from the Lluta Valley until temporary pipe lines and pumping stations had been installed.

There are five tunnels totaling 0.700 km. (2300 ft.) in length, the longest being 190 m. (624 ft.). They were all driven by hand and by top headings and it was necessary to line only a small proportion of the total length.

BRIDGES AND CULVERTS

There are only six bridges on the Chilean section, the

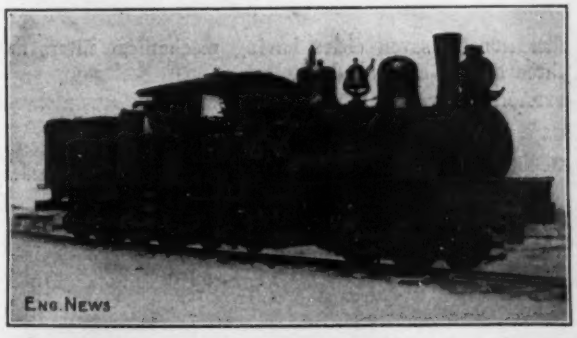


FIG. 6. SHAY GEARED LOCOMOTIVE USED ON THE ARICA-LA PAZ RY.

(From photographs furnished by the Pan-American Union, Washington, D. C.)

longest single span being 30-m. riveted-deck truss. The others all consist of 10-m. deck plate-girders. On the Bolivian section the most important structure is the bridge over the Sesaguardo River consisting of five spans of 20-m. riveted-deck trusses founded on concrete abutments and steel cylinder piers. There are numerous other girder bridges consisting of one or more 5-m. or 10-m. deck spans.

The culverts are of various designs, concrete boxes, pipe, arches, dry stone boxes and stone masonry in various designs, none of which deserve special mention.

TRACK

The track specified for the adhesion section of the line and which was adopted with the exception of 100 km. on the Bolivian section, consists of 27.4 kilo. per m. (55 lb. per yd.) rails with oak ties 1.80x0.20x0.125 m. (5x8 in.x5 ft. 11 in.)—1500 per km. slabbed to receive the tie plates and making the inclination of the rails toward the center 1 : 30. Special plates were used to prevent creeping, the number used per rail depending on the gradient and the curvature. These plates bolt to the web of the rail and are fastened to the tie by three spikes. The joints are of 6-bolt angle splices and are suspended and opposite. There are 100 km. on the Bolivian section laid with 60-lb. rail without tie plates. The line is ballasted throughout with stone and gravel ballast.

WATER SERVICE

The permanent water-supply between Arica and km. 155 is furnished by a pipe line which parallels the railway and which has a minimum diameter of 0.10 m. (4 in.). The supply is taken from a small stream fed by melting snow from the mountains and is of excellent quality for boiler purposes. Beyond this point the water is either supplied from wells from windmills or by short pipe lines from adjacent springs. The average distance between water stations is 20 km.

BUILDINGS AND SHOPS

The station buildings throughout are of stone masonry. There are two large repair shops, one at km. 3 and the other at Viacha, consisting of a 10-stall engine-house, store-house, blacksmith, machine and carpenter shops, car-repair and locomotive-repair shops and a power house.

FIG. 7. ENTRANCE TO A TUNNEL ON ARICA-LA PAZ RY. SHOWING RACK TRACK

(From photographs furnished by the Pan-American Union, Washington, D. C.)

The buildings in km. 3 are of reinforced concrete, with steel saw-tooth roofing and galvanized-iron covering. The shops and buildings are all lighted and driven by electricity and the larger machines are provided with individual motors. Two 200-hp. Diesel engines furnish the power.

In Viacha the same general plan has been followed except that the buildings are of stone, and are about 25% smaller. There are two secondary shops to which the less important repairs will be made. One of these shops is located at km. 70 and the other at km. 112.

Rolling Stock

During the construction there were 15 locomotives and 140 20- and 30-ton flat cars in service. The locomotives were of English, American and German manufacture, and the heaviest weighed about 70 tons.

Operation

The line is now being operated by the Chilean Government, and a temporary train service has been established. At present there is no connection between the Alto of La Paz and the City of La Paz except an electric railway which was owned by the Bolivian Government when the contract for this railway was signed, but which has since become the property of the Mollendo line. It is probable that an extension will be built to the City of La Paz, but the matter is still undecided.

At present all the cargo in Arica is handled in lighters, and for some time past the Government has been discussing plans for the betterment of the port. The improvements are to consist of a new-made breakwater and a protected harbor. Until these improvements are carried out the operation of the railway must be seriously affected.

The construction work executed by Sir John Jackson (Chile) Ltd., has been carried out under the direction of H. C. Wynne Edwards, engineer and resident director for the firm.

Fig. 8. On the Plains of the Upper Andes; Km. 150 of the Arica-La Paz Ry.

Six Current Features of Public Water-Supplies

Through George W. Fuller, of New York City, chairman, the Committee on Water Supplies of the Sanitary Engineering Section of the American Public Health Association presented some interesting facts and opinions on six features or phases of public water-supplies. A condensation of the report and some direct quotations follow:*

Hygienic Aspects—In refutation of the claims put forward occasionally in some quarters that water filtration has little or no appreciable effect upon the health of communities, the committee submitted the accompanying table of typhoid-fever death rates before and after filtration in seven cities having mechanical filters and three having slow sand filters.

TYPHOID DEATHS IN TEN CITIES BEFORE AND AFTER WATER FILTRATION

City	Plant completed	Years in average Before	Years in average After	Typhoid fever death rates Before	Typhoid fever death rates After
Mechanical Filters					
Binghamton, N. Y.	1902	5	5	47	15
Cincinnati, Ohio	1907	4	4	50	12
Columbus, Ohio	1908	11	5	78	11
Hoboken, N. J.	1905	7	6	19	14
Paterson, N. J.	1902	5	9	32	10
Watertown, N. Y.	1904	5	7	100	38
York, Pa.	1899	2	12	76	21
Sand Filters					
Albany, N. Y.	1899	9	9	74	22
Lawrence, Mass.	1893	7	15	114	25
Washington, D. C.	1905	5	6	57	33

To illustrate the fact that high typhoid-fever rates are due in some cities to other causes than the public water-supply, the committee referred to the experience of New Orleans, La., Atlanta, Ga., and Birmingham, Ala., in all of which places high typhoid rates have prevailed

*The report will appear in the "Journal" of the Association during the coming year. The members of the committee besides Mr. Fuller were: George G. Earl, Chas. G. Hyde, Morris Knowles and Francis Langley. The report was presented at Colorado Springs, in September, 1913.

A Flourishing Forestry School is in operation in the Philippine Islands, according to a Bulletin of the U. S. Forest Service. In 1913, 28 men were graduated.

notwithstanding the use of filtered water from plants well designed and well operated. With the exception of one year in each case, the typhoid death rate per 100,000 at New Orleans was much the same for the five years before as for the four years after filtration, thus:

Before filtration		After filtration	
1904	36	1909	29
1905	32	1910	32
1906	30	1911	31
1907	55	1912	14
1908	29		

The New Orleans water-supply has never given much evidence of pollution quite regardless of whether or not the water was filtered. The committee, basing its opinion upon statements in the report of the New Orleans Sewerage and Water Board for 1912, draws the conclusion "that a large share of the cases resulted primarily from importations, some of which produced local foci of the disease, resulting in the spread of the disease through flies, milk and the food supply in the days when there was a lack of sewerage and drainage facilities, as well as of proper care in disinfection." Of the 75,000 premises in New Orleans at the close of 1912, only some 28,500 were connected with the sewer system and 46,000 with the new water-works.

Rate of Installation of Filters—Bringing down to date a table formerly compiled by Allen Hazen, it appears that the total population of the United States supplied with filtered water at different periods has been as follows: 1870, none; 1880, 30,000; 1890, 310,000; 1900, 1,860,000; 1910, 10,806,000; and 1913, 13,290,000.

In the period from 1904 to 1913 no less than 17 cities in the United States with populations of 100,000 or more built filter plants, as follows: Philadelphia, Pittsburgh, Washington, Indianapolis, Providence, Cincinnati, New Orleans, Hackensack, N. J., and vicinity, Louisville, Columbus, Toledo, Atlanta, Birmingham, Scranton, Minneapolis, Grand Rapids and (for a part of) New York City. In Canada filter plants have quite recently been built for Montreal, Toronto and Saskatoon.

Water Sterilization Progress and Limitations—After mentioning the rapid spread of the use of hypochlorite of lime for water disinfection during the past five years, the committee called attention to some of the limitations of the process. Besides the fact that hypochlorite does not remove turbidity, color, organic matter, nor objectionable taste and odors to any appreciable extent, while suspended matters in the water interfere with the process, the committee has the following to say regarding bacterial reductions:

> Latterly it has been recognized more and more that the treatment fails to destroy certain kinds of bacteria which, owing to their spore-forming chacteristics, are very resistant to the toxic effect of the chemical. There is considerable evidence, too, to indicate that this treatment, as applied in the United States, does not actually destroy all of the bacteria, but simply stuns them or drugs them for a time, or in other words, has a toxic effect which prevents them, for the time being, from developing on the ordinary culture media.

Hypochlorite "is valuable indeed in many emergencies, and valuable always as an adjunct to filtration." Where water is unusually free from suspended and organic matter hypochlorite treatment "may be considered all-sufficient, but the principal applicability of the treatment is for emergency use or as a finishing process after filtration."

Liquid chlorine in place of hypochlorite is given favorable mention, but the committee considers it as yet on trial.

Ozone treatment is still beset with difficulties, especially as regards the mixing of the ozone and the water, and the unsuitability of ozone for treating water high in turbidity and organic matter.

Ultra-violet rays are in much the same category as ozone, their use being costly, complicated and the rays being applied to large volumes of water only with difficulty.

The committee suggests that the whole subject of sterilization of water is a fit one for comprehensive study.

Decolorization with an Overdose of Coagulant—Recent experience at Springfield, Mass., has shown that the occasional high color in the water could be materially reduced by relatively heavy treatment with sulphate of alumina intermittently. After applying this coagulant to the water as it enters the sedimentation basin the water is held in the basin for several hours. The overdosed entering water mixes with the water already in the basin which contains relatively little or none of the coagulant. During a period of seven months in 1912 an average dose of 0.23 grain per gallon of aluminum sulphate reduced the color from an "average of 37 in the raw water to 15 in the filtered water." It is believed that the softness of the water (average alkalinity about 10 p.p.m.) and the unusually large capacity of the coagulating basin contribute materially to the success of this treatment under conditions existing at Springfield. The process is considered worthy of careful study elsewhere. The opinion is expressed that "the success of the method depends upon more or less obscure laws of physical chemistry."

Decolorization as an Adjunct of Water Softening—Experience with a new water-softening and filtration plant at Grand Rapids, Mich., during the past year has shown that the lime which is used for softening the water reduces the total hardness of some 250 p.p.m. to less than 100 parts, while at the same time, "through the removal of magnesia, a high color is reduced to less than 10 parts." This is accomplished at less cost "than would be required for treatment with sulphate of alumina to secure equal decolorization." The latter agent, however, is used to the extent of about 0.5 grain per gallon to lessen the turbidity of the softened water before it reaches the filters.

Corrosion of Metals—As a rule hard waters cause little or no corrosion in metal pipes, due largely to the formation of protective coatings upon the metal by the material in the water. The carbonic acid and atmospheric oxygen in soft waters, in contrast, give rise to corrosion.

The committee refers briefly to investigations made in 1912 by Drs. D. D. Jackson and Frank A. Hale, of the Mount Prospect Laboratory of the Department of Water Supply, Brooklyn Borough, New York City, on "the corrosive properties of the Croton water, particularly its influence by the use of sulphate of alumina for purposes of decolorization." Studies have been largely "devoted to the use of lime or soda to remove free carbonic acid and thus reduce the corrosive tendencies of the water." The results of these laboratory studies indicate that the addition of lime or soda to the water forms "coatings on the inside of the pipes so that corrosion may be practically neglected." The studies will be given in the report of the department named for the year 1912.*

*A paper on these investigations was also read before the American Public Health Association during the convention at which this report was presented.

Subaqueous Sewer Construction, Brooklyn, N. Y.

SYNOPSIS—This article describes and illustrates many typical details of a sewerage system constructed in fine, running sand, at from 1 to 14 ft. below ground water-level. All the sewers in the section of Coney Island in the Borough of Brooklyn, New York City, in which this work was done are built on plank platforms supported by piles driven deep enough to prevent injury to the sewers by loss of the surrounding sand when excavations are made in the vicinity. The sanitary and storm-water pipe sewers and the house connections are incased in concrete, insuring a rigid support and water-tight joints. Cost data are given at the end of the article.

The Borough of Brooklyn, New York City, covers nearly 39,000 acres, and has, according to the census of 1910, more than 1,634,500 inhabitants, which gives a density of population for the entire area of about 42 per acre. There are still many outlying portions where there are practically no habitations, but Brooklyn is a fast growing community, and in 15 years with increased transportation facilities it is estimated that this borough will have a population equal to or greater than that of the Borough of Manhattan.

For the most part these newer portions of Brooklyn are comparatively level and low, the ground water level is high, the street and drainage systems are somewhat complicated, so that many problems both difficult and interesting are constantly to be dealt with in sewer construction and reconstruction work.

Coney Island is the name given to an extensive section at the southern extremity of Brooklyn, lying between Gravesend Bay and the western entrance to Jamaica Bay. It has been famous many years as a popular shore and amusement resort, but of late years it has acquired a large permanent population. In considerable portions of this part of Brooklyn sewers are now being constructed for the first time, and the work involves much construction of a type not usually met with in sewerage systems covering large areas, in this part of the country, although somewhat similar work has been done in New Orleans, La.

The soil over this whole area consists of fine white sand, with a surface elevation but a few feet above high water in the bordering ocean and with practically no natural drainage. Because the entire coast adjacent is a sand beach used for bathing by multitudes of the city's poorer classes no sanitary sewers can be discharged along the ocean front. All this drainage is carried to the north side and after treatment discharged into Gravesend Bay; only a small portion of the storm-water sewers are discharged into the ocean fronting Coney Island.

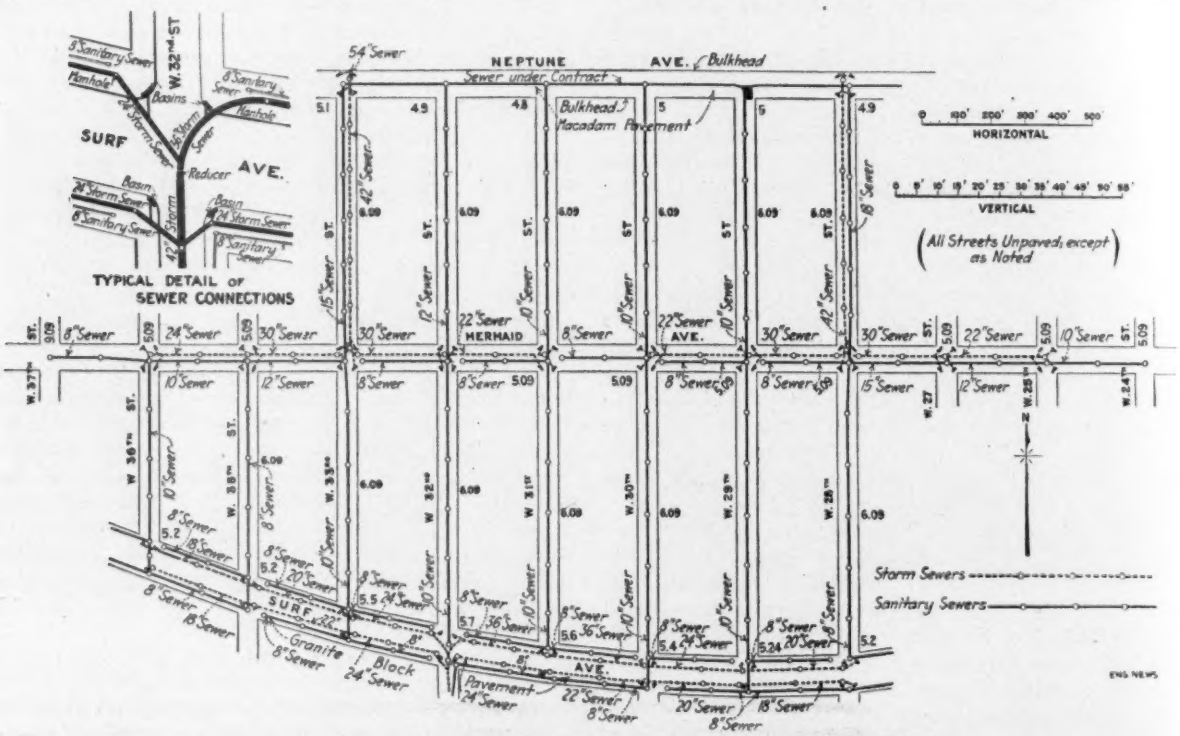


FIG. 1. PLAN OF PORTION OF CONEY ISLAND, BOROUGH OF BROOKLYN, NEW YORK CITY, SHOWING SEWERAGE SYSTEM

To illustrate the character of some of the unusual work in this area a typical contract section has been taken—there are many miles of similar work—and some of the more interesting details described and contract cost prices given.

The bids for all sewer work in Brooklyn are based on carefully prepared unit price estimates. The contractor bids for the work at a percentage of the engineers' preliminary estimate. This percentage bid is on the sum total of the contract but applies also to each separate item. The average of the lowest bids during the past year has

been about 91% of the engineers' estimate and the average of the average bids about 99% of the engineers' estimate, so that, in most cases the engineers' estimates have given very close results as to actual cost, plus a fair profit for the contractor.

GENERAL PLAN—The section of work here described and illustrated lies between Surf Ave., Coney Island's principal street, and the low sandy territory to the north shown on the plan, Fig. 1. An idea of the topographical character of this area may be had from the elevations at street intersections (shown on the plan), which are referred to mean high tide, the sewer datum of the Borough of Brooklyn, which is 1.72 ft. above mean sea-level. Surf Ave. is well built up and resembles the main thoroughfare of a city of considerable size. A large part of the area shown is built up with a poor class of tenements and dwelling houses, while the rest is unoccupied.

House connections are everywhere provided for at intervals of 20 ft., except where manholes interfere with the regular spacing, on both sanitary and storm sewers, the storm-sewer house connections, of course, being merely to take the drain water from roofs, etc. The elevation of all house-connection drains on sanitary sewers at the curb is 0.0 wherever possible (about 6 ft. below the surface), in other cases, where the sewers are higher than this, the invert elevation at the curb is coincident with the inner top of the sewer with which the drain connects. The elevation of house-connection drains on storm sewers at the curb line is 6 in. below the inner top of the sewer with which it connects.

Fig. 2 shows profiles of the sanitary and the storm sewers on the north (upper) side of Surf Ave. From Surf Ave. both the sanitary sewers drain through the north and south streets to Neptune Ave., where an automatic pumping station at the corner of 29th St. lifts the sanitary drainage of this whole area 9.36 ft. to a new level.

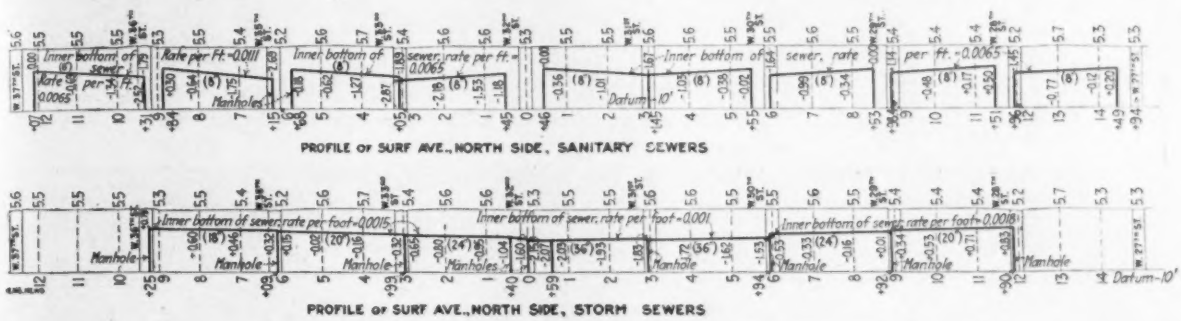


FIG. 2. PROFILES OF SANITARY AND STORM SEWERS, NORTH SIDE OF SURF AVE.

A plan and profile of the sanitary sewers in Neptune Ave. are shown in Fig. 3.

AUTOMATIC PUMPING STATION—The pumping plant consists of two electrically driven 6-in. centrifugal pumps, with provision for a third, each having a capacity of 1000 gal. per min. against a total dynamic head of 25 ft., when operated at a speed of approximately 800 r.p.m. The pumps are of the volute type, on vertical shafts, and have single bottom suction open impellers suitable for pumping raw sewage.

The automatic starting and stopping device is of the standard types manufactured by the General Electric Co. and the Westinghouse Electric & Manufacturing Co. The operating parts are inclosed in oil and are moisture-proof throughout. The starting device limits the starting current to less than twice the full-load current per phase. The self-starter is connected to an overload release which stops the motor on a 75% overload, and which will also ring a 4-in. alarm bell. The first pump commences to operate when the sewage level in the float chamber rises to an elevation of —11.75 ft. and the second pump when the level is 1 ft. higher.

The pumps and operating machinery are housed in a reinforced-concrete chamber below the street level. This

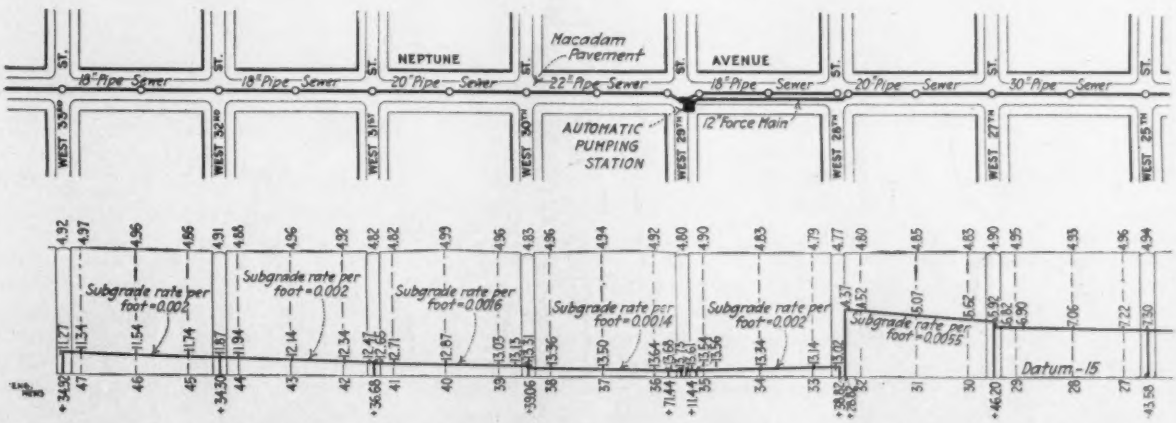


FIG. 3. PLAN AND PROFILE OF SANITARY SEWERS IN NEPTUNE AVE.

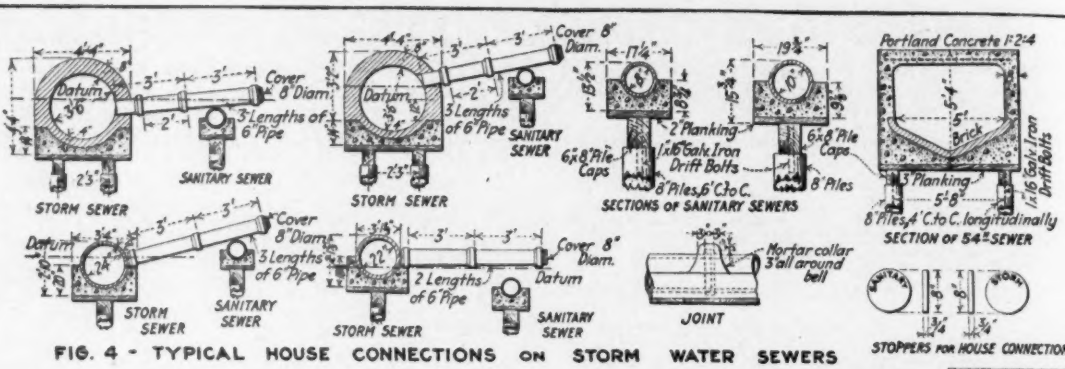


FIG. 4 - TYPICAL HOUSE CONNECTIONS ON STORM WATER SEWERS

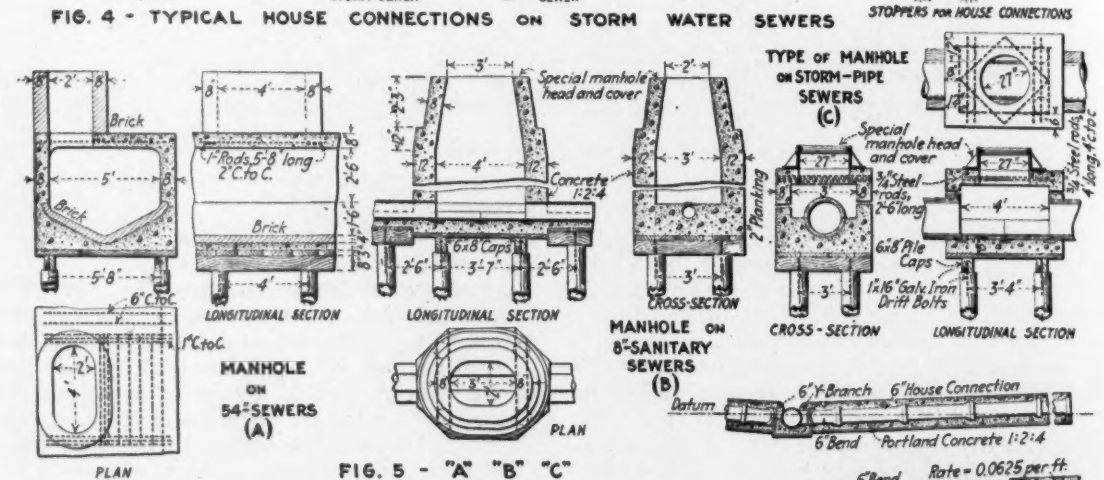


FIG. 5 - "A" "B" "C"

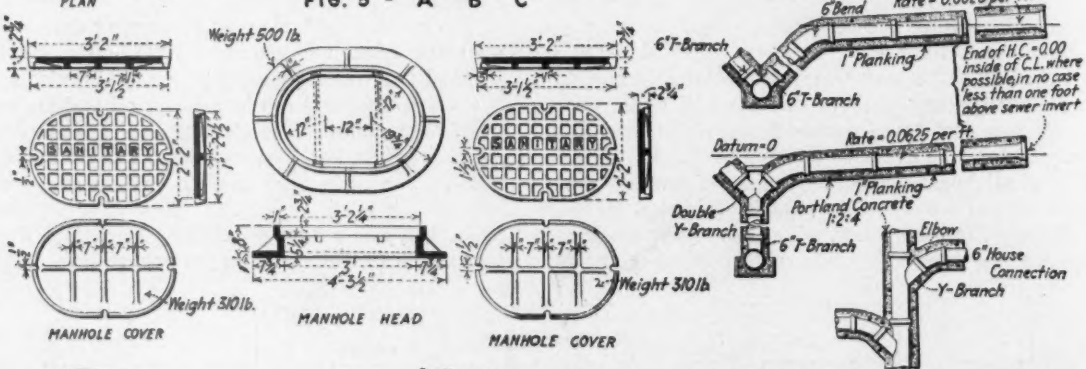


FIG. 7 - TYPICAL STANDPIPE AND CONNECTIONS

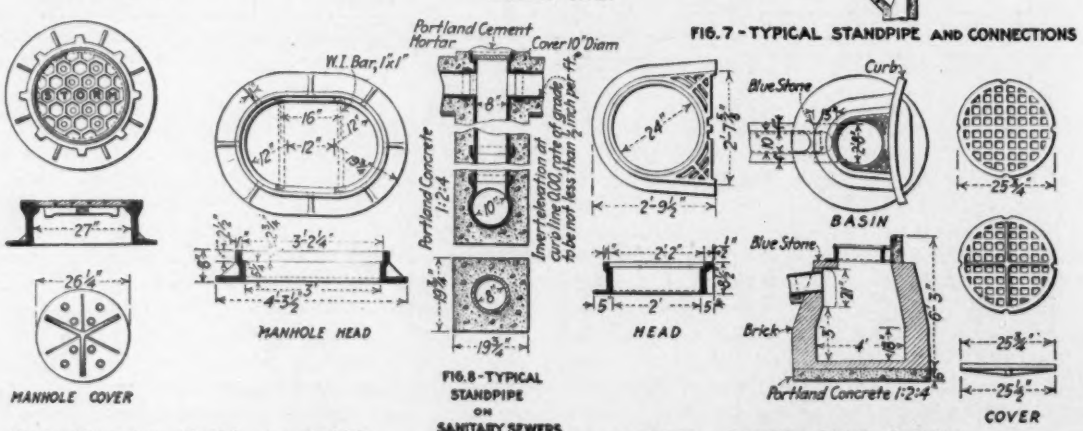


FIG. 6 - MANHOLE COVERS AND HEADS

FIG. 9 - SEWER BASIN DETAILS

TYPICAL DETAILS, SUBAQUEOUS SEWER WORK,

Brooklyn Borough, New York City

chamber is provided with electric lights, a ventilating fan and other accessories, and is entered through a manhole in the sidewalk.

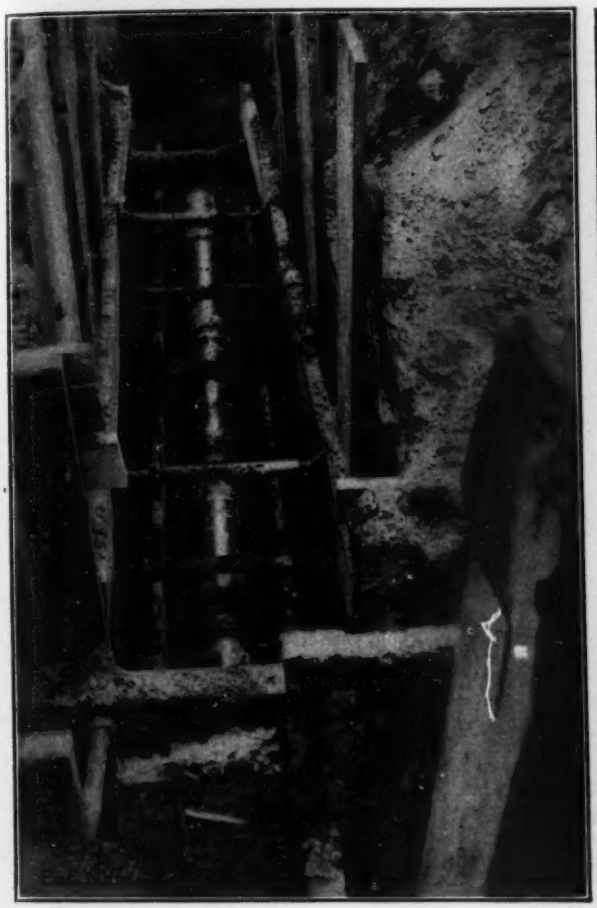
Sewer Construction Methods and Details

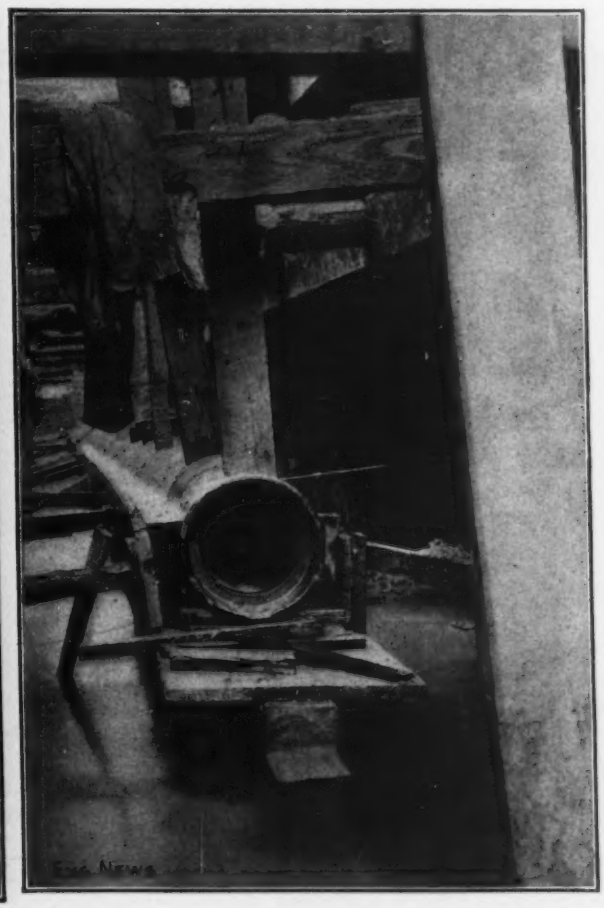
The foregoing description of the topography makes it self evident that practically all the sewers in this vicinity are below the ground-water level. The subaqueous nature of the work, coupled with the character of the soil, a fine running sand, makes the details of construction unusual and more than ordinarily expensive.

The ordinary method of making a pipe-sewer foundation in soft material by the use of a plank platform laid in the bottom of the trench could not be used here because of the danger of the water-soaked sand flowing out from under the foundation whenever an opening was afterward made in the vicinity. This has required the construction of many miles of sewers on pile and plank foundations, with all pipe, standpipes and house connections embedded in concrete (Fig. 4), in order to insure a stable and water-tight drainage system.

Piles—The opening between piles longitudinally varies from 4 to 6 ft., for the different sizes of pipe (Fig. 4). The approximate length of the piles below the cutoff is 8 ft., and the diameter at the cutoff is not less than 8 in. The specifications require the piles to be of good sound pine, spruce or hemlock, free from shakes and equal to the standard requirements of the New York City Department of Docks and Ferries.

The general specifications require the piles to be driven by a 2000-lb. hammer, but in this work the contractor is allowed to use a water jet, which is the method which has been commonly employed. The piles were never omitted except where in the judgment of the engineer their use is unnecessary. The contractor is paid by the linear foot for each pile driven, and he has no claim for expected profit on piles omitted by direction of the engineer.





Figs. 10 and 11. Sanitary Pipe Sewers under Construction, Showing Concrete Casing, Plank Platform and Pile Foundation

Planking and Stringers—The foundation planking, pile capping and stringers required (Fig. 4) were specified to be of sound pine, spruce or hemlock, and unless otherwise particularly specified, were to be free from shakes, cracks, large or loose knots, decay, wormholes and knotholes, or other defects impairing their strength or durability. The pile capping and stringers are secured to the piles by 1x16-in. galvanized-iron drift bolts, as shown in Fig. 4, and the foundation planking is securely spiked to the capping or stringers.

The spikes for the under-water planking and stringers are ordinary dock spikes. According to the specifications the spikes need not be headed, but may be cut from round

or square bars to the required lengths and sufficiently pointed at one end to allow their being readily driven. When the timber is hard or dry enough to require boring for spikes, holes must be bored ⅛-in. less in diameter than the diameter of the spikes. The length of the spikes must be sufficient to pass through the first timber or timbers and into the last one at least 6 in., or its full thickness. Spikes are $\frac{7}{16}$-in. square or ½-in. round for timbers up to 8 in. in thickness and ⅝-in. square or ¾-in. round for timbers 12 in. and over.

The foundation planking, pile capping or stringers may be omitted at the discretion of the engineer; the contractor is paid for the actual amount put in at the percentage of the unit price bid, and has no claim for expected profits on such construction as may be omitted by direction of the engineer.

FIGS. 12 AND 13. TRENCHING FOR 54-IN. STORM SEWER

MANHOLES—Fig. 5 shows clearly the method of construction of typical manholes. Some of the sanitary sewer manholes are constructed with round openings 25 in. in diameter, but in other essentials they are exactly like the one shown in Fig. 5. Cover designs for the sanitary and storm-sewer manholes are shown in Fig. 6. These details are interesting as showing the latest practice of one of the largest sewerage engineering organizations in this country.

HOUSE DRAINS—The method of connecting the house drains is shown in Fig. 7. After some experience with installations of this kind it was found in most cases very difficult to maintain a good foundation under the bend, settlement during construction causing the concrete casing to crack, so the connections have since been made between the standpipe and the house drain through a straight T without the use of a bend.

Provision is made in the specifications for placing piles and foundation planking under the house drains when these are necessary, although in most cases the concrete-boxed drain shown in Fig. 7 answers the purpose.

Tile stoppers are provided for every unconnected house drain and are labeled "Sanitary" and "Storm." Special care is required of the contractor to see that these stoppers are placed in their proper places. Fig. 8 shows a typical 8-in. standpipe section.

SEWER BASINS—The details of the standard sewer basin used in this work are shown in Fig. 9. The specifications for basins require the excavation to give not less than 1 ft. in the clear, inside any shoring or bracing that may be needed. The culvert pipe is 10 in. in diameter. Unless the location of other subsurface structures prevent the culverts are laid with straight lines and grades between the sewers and the basins they connect.

In unpaved streets where basins are built approximately to the grade of the street surface, a space 3 ft. in width about the basin pan is required to be paved with granite blocks and the cost included in the price of the basin. In case the street and sidewalk are not graded to the established grade at the point where the sewer basin and manholes are built, such temporary arrangements are made for the inlet as the engineer may direct.

STORM SEWERS—The specifications for the concrete in all the work, including the 54-in. storm sewer, require a mixture of one part portland cement, two parts of clean sharp sand and four parts of broken stone which shall pass a 1-in. ring. Clean gravel may be used in place of broken stone in concrete for all portions of the structures except for the roofs of storm sewers. The concrete is mixed wet so that ramming is not required.

For all brick masonry none but the best quality North River brick, or bricks of equal quality, burned hard entirely through, are used. The joints except in the arch, are required to be carefully struck on the inside. The exterior of the arch above the spring is coated with cement mortar ½ in. thick. The bonds in all cases are formed with a row of headers every sixth course, except in arches and inverts.

GENERAL SPECIFICATIONS—Some of the more interesting provisions of the specifications for the work not described in the foregoing text are given below. Owing to the unstable character of the soil the protection of the water mains before and after construction is an important element.

PROTECTION OF WATER MAINS

(1) When the construction of the proposed sewer and appurtenances renders necessary the temporary removal of

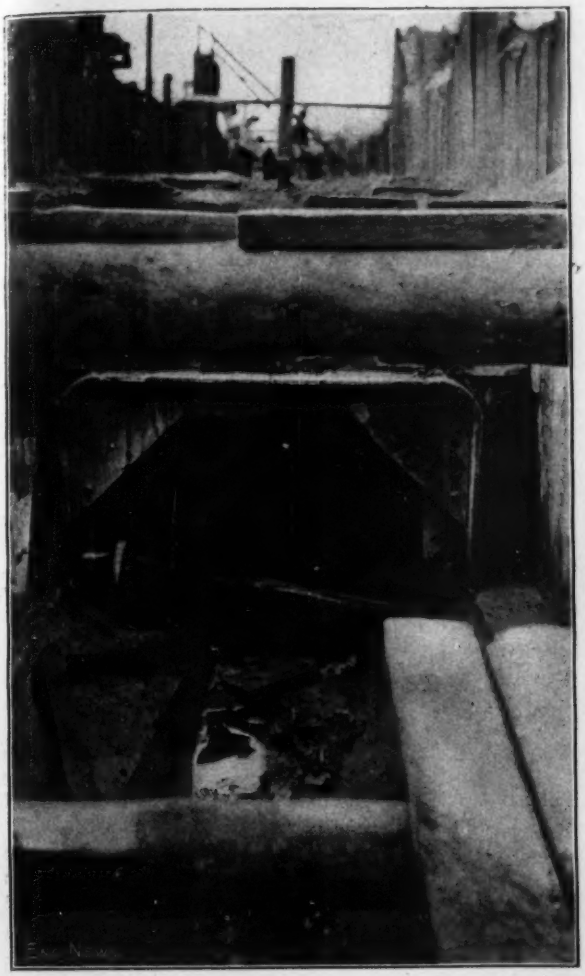


FIG. 14. INVERT AND FORM IN PLACE FOR 54-IN. REINFORCED-CONCRETE STORM SEWER

any main or service water-pipe or pipes, or when the proposed sewer and appurtenances follow the lines or occupy the place of any existing water-main, such main or pipes shall be removed, replaced and relaid by the Contractor at his own cost and expense, or, in case he shall fail to do so, by the Department of Water Supply, Gas and Electricity, in which case the cost of such work shall be charged to the Contractor and may be deducted from any sum or sums due or to become due and payable to the Contractor under this contract.

(2) All iron, water and gas pipes which it becomes necessary to remove shall be considered as the property of the City as between it and the Contractor, and shall be left in such part or parts of the streets as the Chief Engineer of the Department of Water Supply, Gas and Electricity may direct, unless notice to the contrary is given in writing by the President of the Borough to the Contractor, at the request of such Chief Engineer, in which case the same shall be removed or otherwise disposed of at the expense of the Contractor.

(3) The Contractor shall sustain in their places without injury, by timbers and sufficient chains, all the main and service water-pipes which may be affected in any manner by the work done under this agreement, and shall protect all service-pipes from freezing, and he failing to do so, the Commissioner of Water Supply, Gas and Electricity shall be and is hereby authorized to replace such pipes, and recalk and repair the same immediately, in each block, as the work progresses, and the cost thereof shall be charged to the Contractor; the cost so charged to the Contractor shall be deducted from any sum or sums due or that may become due and payable to the Contractor under this contract.

(4) All work in any way affecting water-mains or water service-pipes shall be done to the satisfaction of the Chief Engineer of the Department of Water Supply, Gas and Electricity, and under the supervision of inspectors to be appointed by the Commissioner of Water Supply, Gas and Electricity, which inspectors shall be paid by the Contractor at the rate of $3.75 per day during the actual progress of such work, and no such work shall be commenced without the written permit of the Commissioner of Water Supply, Gas and Electricity having been first obtained and approved by the President of the Borough.

(5) The Contractor shall give notice in writing at least 24 hours before breaking ground, for the purpose of constructing the work of this contract, to the Department of Water Supply, Gas and Electricity.

TRENCHES

(1) The trenches for pipe sewers up to and inclusive of 18-in. pipe, shall be 8 in. wider, inside the sheeting, on each side than the greatest external width of the sewers intended to be laid in them, and 10 in. wider on each side of larger pipe. The clear width of trenches for other sewers shall be as great as the external width of the structures to be placed therein, without undercutting of the banks, space being provided for all necessary forms.

(2) No more than 200 ft. of trench shall be opened at any one time in advance of the complete building of the sewer, unless by written order of the Engineer, and for a distance therein specified. Trenches for house-connection drains shall not be opened on both sides of the street at the same time, in a manner to needlessly obstruct the roadway, unless permission has been previously given by the President of the Borough to close the street.

(3) In built-up districts or in streets that are thoroughfares, the material excavated from the trench for the first 100 ft. in length shall be removed by the Contractor as soon as excavated, and the material subsequently excavated shall be used to fill in the trench where the sewer has been built. This is done so as to insure that there will be no surplus material lying on the line of the street at any time during the construction of said sewer. Any extra material required for filling at the completion of the work shall be procured by the Contractor, and at all times the gutters shall be kept open for surface drainage, and the streets and sidewalks shall be kept clear and free for the passage of vehicles, cars and pedestrians, unless otherwise authorized by special permission in writing from the President of the Borough.

(4) Old material, except basin-heads, gas and water pipes, and old sewer pipe desired for use by the Bureau of Sewers, or materials not required by the City and not to be used on the work, shall become the property of the Contractor. Materials required by the City, as above specified, must be removed by the Contractor to the nearest corporation yard, when directed by the Engineer.

FIG. 15. WATER MAINS SUPPORTED DURING SETTLEMENT OF FILL

(5) As the trenches are filled in and the work progresses, the Contractor shall cart away or remove all surplus earth, stone and other material from the ground, to such places on the line of the work as the Engineer may direct, and leave all roads and places free, clear and in good order. In case the Contractor fails or neglects to do this within 48 hours after the service, in any way herein provided, of a written notice from the Engineer, the President of the Borough may remove such surplus material from the roadways, sidewalks and other places, and the cost of said work shall be charged to the Contractor and deducted from any moneys due or to become due him under this contract, without further notice thereof.

(6) After the completion of the sewers and their appur-

tenances, and before final acceptance of the work, should the Engineer require it for his better satisfaction, the Contractor shall make such openings, and to such extent, through such part or parts of the said sewers and appurtenances, as the Engineer shall direct, and he shall restore the part of the work so disturbed to the satisfaction of the Engineer. Should the work be found faulty in any respect, the whole of the expense incurred thereby shall be defrayed by the Contractor, but, if otherwise, by the City.

COST DATA—The engineers' estimate of cost of the sewers in the section shown in Fig. 1, north of Surf Ave. (Surf Ave. and 29th St. to Mermaid Ave. contract had not been let at this writing) and south of Neptune Ave. is given below. These figures include every operation connected with the construction of the sewerage system, the materials, all incidentals, appurtenances, etc.

COST DATA ON CONEY ISLAND SEWERS

(1) 36 lin.ft. of 54-in. brick and concrete sewer at $10, $360.
(2) 1660 lin.ft. of 42-in. brick and concrete sewer at $8.50, $14,110.
(3) 1185 lin.ft. 30-in. brick and concrete sewer at $5.20, $6162.
(4) 298 lin.ft. 24-in. pipe sewer at $4.10, $1221.
(5) 893 lin.ft. 22-in. pipe sewer at $3.90, $3482.70.
(6) 836 lin.ft. 18-in. pipe sewer at $5.90, $4932.40.
(7) 1131 lin.ft. 15-in. pipe sewer at $4.60, $5202.60.
(8) 1428 lin.ft. 12-in. pipe sewer at $3.70, $5283.60.
(9) 7171 lin.ft. of 10-in. pipe sewer at $3.40, $24,381.40.
(10) 8198 lin.ft. of 8-in. pipe sewer at $2.25, $7195.50.
(11) 6040 lin.ft. of 6-in. house connection drain (st[illegible]) at $1.10, $6644.
(12) 18,000 lin.ft. of 6-in. house connection drain (sanitary) at $1.80, $32,400.
(13) 426 Standpipes, complete, including double branches, concrete casing, etc., at $4, $1704.
(14) 128 manholes complete, with iron heads and covers, including incidentals, etc., at $60, $7680.
(15) 48 sewer basins, as shown on plans with iron heads and gratings, iron-basin hoods, including connecting culverts with concrete cradle, etc., at $140, 6720.
(16) 275,000 ft.b.m. of foundation planking and pile capping laid in place complete, with all incidentals and appurtenances at $28 per M., $7700.
(17) 10,000 ft.b.m. sheeting and bracing driven in place complete at $20 per M., $200.
(18) 31,000 lin.ft. piles driven in place complete, at $0.25, $7750.
Total, $143,130.

The contract for the work enumerated was let for 104% of the engineers' estimated cost of $143,130, or for $148,850. The contract time for the completion of the work was 300 days.

PERSONNEL—Each of the Boroughs of New York City has a separate sewer department. The Chief Engineer of the Bureau of Sewers of the Borough of Brooklyn is E. J. Fort, and the Designing Engineer is G. T. Hammond, to both of whom we are indebted for the plans and data given.

The Panama-Pacific Exposition

BY A. H. MARKWART*

SYNOPSIS—The engineering works of a great exposition are designed under the peculiar conditions of having to render ample service for a comparatively short period, while they must be of an economical character since they are to be used only for this time. The accompanying article describes particularly the lighting, water-supply, sewerage, paving and transportation features of this coming exposition. A previous article by the same author, in our issue of Nov. 6, 1913, dealt with the organization, planning, architecture and decorative features, and the design and construction of the buildings.

[The first three illustrations show some of the architectural features. The Service Building, Fig. 1, is the headquarters of the Division of Works and its staff, as described in a previous article. Figs. 2 and 3 show some of the towers of the central group and also one of the main courts.—ED.]

ELECTRIC LIGHT AND POWER

A system of mains provides for the distribution of electric current for lighting and power purposes. In the buildings, light will be furnished from 60-cycle, 3-phase, 4-wire mains having a voltage of approximately 115 between conductors and neutral. The lighting in all other districts will be served from 60-cycle, single-phase, 3-wire mains, having a voltage of approximately 115 to neutral and 230 between outside conductors. For power throughout the grounds, 60-cycle, 3-phase and single-phase service, at 230 volts will be available. In addition to alternating-current service, the Mines, Transportation and Manufactures buildings, and the concessions district, will have mains for the distribution of direct current at 125 and 250 volts.

The layout for decorative purposes contemplates the use of luminous arc lamps with special diffusing globes to keep the intrinsic brilliancy low. These will be used in the streets and courts of the exhibit section to illuminate the facades. Special features in water and light effects will occur in some of the courts. The Bureau of Illumination has developed what is believed to be a new scheme for exterior illumination. The old idea of outlining the buildings and architectural features by means of incandescent lamps will not be used, but the entire facade of each building and tower will be flooded with light by means of the screened luminous arcs and hidden batteries of searchlights.

A unique feature in the decorative illumination scheme is the use of some 125,000 imitation jewels in various parts of the towers and colonnades. These jewels will be what are known as Sumatra cut gems, 21 to 47 mm. diameter, with all the facets tin-polished. They will be mounted in such a way as to be moved easily by the air currents, so that they will glitter and scintillate in the sun's rays by day and in the rays of the artificial lights by night.

While not properly a part of the illuminating scheme, there is planned an unusual effect to take the place of pyrotechnic displays. A battery of searchlights situated on the north front of the exposition will play upon the fogs which sometimes prevail in the vicinity of the site. Thus, on foggy nights this natural condition will be made a unique and spectacular feature. In clear weather, artificial clouds of steam and smoke will be produced, upon which will be flashed the beams of the searchlights.

Considerable attention was given to the matter of the

*Assistant Director of Works, Panama-Pacific International Exposition, San Francisco, Calif.

load requirements, and the present idea is based on the assumption that the only buildings open at night will be the Festival Hall, the Ferry Building and the Fine Arts, Motor Transportation, Service and various administration buildings. All other company buildings are assumed to be closed at night, but due allowance has been made to cover the short days when the lighting load will overlap the day motor load.

The average requirements for patrol and janitor service, and lighting of main exhibit buildings was figured on the basis of $\frac{1}{10}$-watt per sq.ft. of building area. To this amount addition has been made of an estimated amount sufficient to cover the requirements for motors, booth lighting, incandescent decorative lighting and lighting of detached buildings. In the section for the State and the foreign and Federal governments, the load was based on 1 watt per sq.ft. of building area, with this area taken as 66% of the total ground area of these districts.

For direct-current service in the four main buildings as mentioned, and the concession district, a total of 1250 kw. is allowed. Direct-current service is contemplated only when the nature of the apparatus absolutely requires it.

Under the general assumption above outlined, the average night peak has been taken as follows: luminous arcs, 1000 kw.; exposition buildings, etc., 2500 kw.; foreign states and U. S. Government, 2000 kw.; concessions, 2500 kw.; searchlights, 500 kw.; average peak, 8500 kw. The capacity of the conductors is such as to provide for dark days when ground lighting would come on before closing down the motor load. Under this assumption the conductors are designed for a total peak load of 11,500 kw.

It is planned to use an overhead system around the back of the concessions district and in the extreme western part of the grounds in the vicinity of the racetrack and drill grounds. Electric service in all other sections of the grounds will be by means of an underground conduit system, using wood-fiber duct and manholes of wood construction. The box or trough construction will extend between manholes and will vary in size to suit the number of ducts to be provided. The space between the duct and the wood trough is to be filled with sand, except at the entrance to the manholes, where 4 lin.ft. of concrete will be used. This construction is shown in Fig. 4.

This type of underground conduit was used because of its mechanical strength and economy. The short life required an economical design throughout, and the average cost of installation is 10c. per duct-foot, with the wood manholes averaging $25 and $50 each for the shallow- and deep-section types, respectively. No subway-type transformers will be used, as all transformers will be placed in fireproof vaults in suitable places in the main exhibit places.

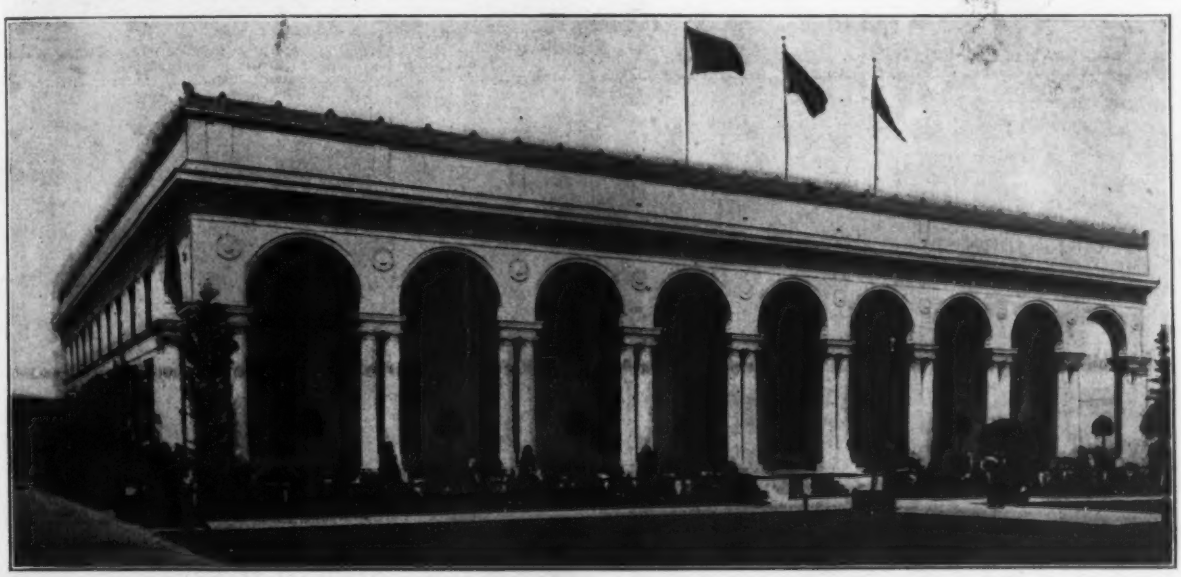


FIG. 1. THE SERVICE BUILDING AT THE PANAMA-PACIFIC INTERNATIONAL EXPOSITION; SAN FRANCISCO, CALIF.
(Headquarters of the Division of Works.)

A telephone system will be provided for the operation of the electric division and special conduits will be reserved for this purpose. In addition, the local telephone company will provide a telephone installation. This will be an underground system throughout.

All electric energy will be distributed throughout the grounds at a primary voltage of 4000 a.c., with secondary voltages as noted above. All electric energy will be purchased by the company from a local power company which will construct a central station in the rear of the Machinery Palace. While the distribution voltage is 4000, it is likely that the generating voltage will be 11,000, and will be stepped down to the required primary voltage. In the event of the central station being temporarily disabled, power will be drawn from other sources of the power company.

GAS, STEAM AND COMPRESSED AIR

There is to be a high-pressure system of mains installed by the local company for distributing oil-gas made from California petroleum and having a heat value of 600 B.t.u. per cu.ft. (or more), with a candlepower in excess of 18. The pressure will be 30 lb., reduced as desired by means of regulators. The low pressure in

buildings will be about 6 in. of water. In general, gas will be used for lighting and heating purposes, as no other source of heat will be allowed (except electric power) unless special permission is granted, as it is desired to reduce the fire hazard to the minimum.

All of the ground lighting for emergency purposes will be by means of gas arc lamps. This provides essentially a secondary lighting system throughout the main district and about such other buildings and entrances as public safety may require. In the States and foreign section and in the concessions district, the street lighting will be by means of gas arcs, and in the latter district the gas lighting system becomes essentially a secondary service.

States and foreign districts a separate system will be provided. The storm-water flow from these last areas (with that of the stock exhibit, race tracks and drill grounds) will be carried directly to the bay through several convenient outfalls. All other storm waters and all sewage will be carried to an outfall at the foot of Pierce St., except that the roof water of the Agriculture palace and a portion of the storm water from the adjacent courts will be carried through a separate storm sewer to the boat harbor.

The Pierce St. outfall sewer is now being constructed through the site by the city, to serve a district of 800 acres immediately surrounding the exhibition grounds.

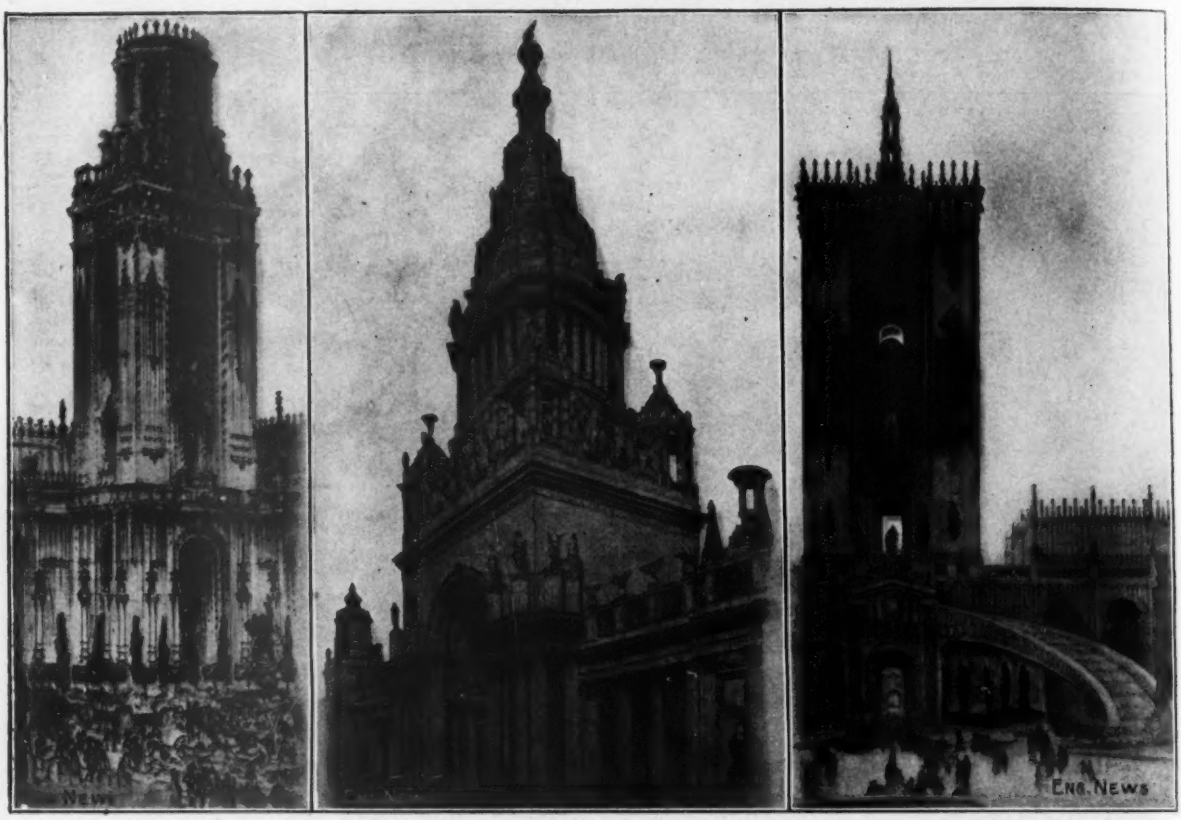


FIG. 2. THREE OF THE TOWERS AT THE PANAMA-PACIFIC INTERNATIONAL EXPOSITION
[From the architects' drawings. Copyright by the Exposition.]
(The Main Tower is in the center. At the right is the Organ Tower and at the left a corner tower, both in the Court of Abundance.)

Steam service (about 1000 to 1500 boiler-hp.) will be available in the Machinery Palace during the day. Saturated steam at 150 lb. pressure will be furnished through a system of mains from the Fuels Building (behind the Machinery Building) and the central station. In the Fuels Building will be established all such exhibits as steam and gas producers.

A limited supply of compressed air at 80 lb. pressure will be available in the Machinery, Mines and Transportation palaces. The distributing system will consist of screw-joint pipe, and the present plans contemplate the installation of an equipment sufficiently large to deliver 1500 cu.ft. of free air per minute.

SEWERS AND SANITARY EQUIPMENT

In the main section and in the concessions district a combined system of sewers is contemplated, while in the

The city is also constructing two intercepting sewers from the foot of Laguna and Baker Sts. to Pierce St., which will discharge into the outfall at Tonquin St. The exposition's combined and sanitary systems are connected to the city system in a number of convenient places and in this manner all sewage will be disposed of at one outfall. This is desirable, as the water front must be clear of objectionable matter. The city has assisted in this to the extent of making provisions for the outfall to discharge at 23 ft. below city datum. The outfall is designed to discharge the maximum calculated flow at extreme high tide (4 ft. below datum).

The entire system is simple and direct and no particular difficulties of design were encountered. The grades were necessarily flat because of the nature of the site and its close proximity to the water level. It was found necessary to install a sewage pump and sump in the States

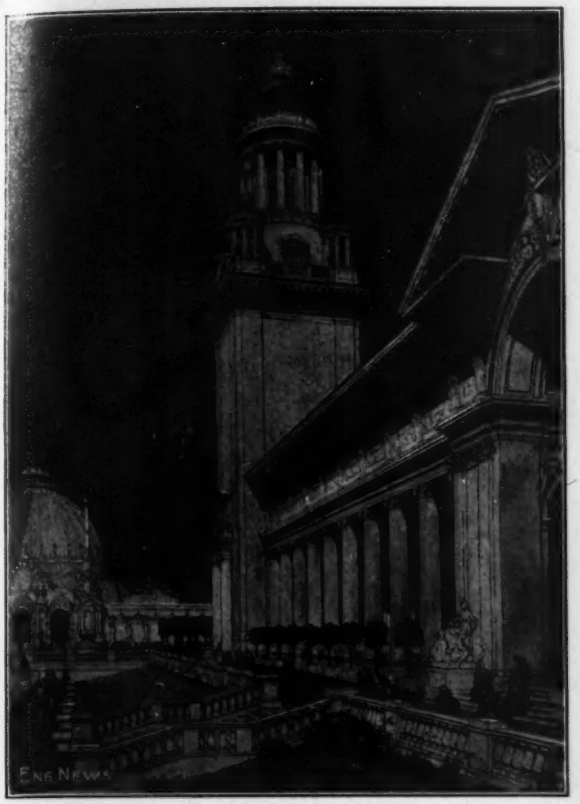


FIG. 3. COURT OF PALMS, WITH EDUCATION BUILDING ON THE RIGHT AND THE DOME OF THE HORTICULTURE BUILDING IN THE BACKGROUND
[Copyright by the Exposition.]

and foreign district for lifting the sewage of this section to the west branch of the Tonquin St. intercepting sewer. No other features of note were required.

The sewer system is based upon the use of second-quality vitrified pipe and wood-stave pipe, as determined by the cost of each. Other conditions, however, entered into the selection of wood-stave pipe for the sanitary sewers of the States and foreign district. As all sewage of this section had to be pumped, it was desirable to install such pipes as would reduce the leakage of ground water into the system to the minimum. Further, in view of the settlement which was constantly taking place in that portion of the main area composed of the recent hydraulic fill, it was desirable to provide a type of pipe which had some flexible qualities, and to meet this condition wood-stave pipe was used to some extent also in the palace areas. As a rule, it was found that the greatest economy resulted in using 8- to 15-in. vitrified pipe and 18- to 30-in. wood-stave pipe. The manholes are of concrete or wood, and the catch-basins are of wood, as shown in Fig. 5.

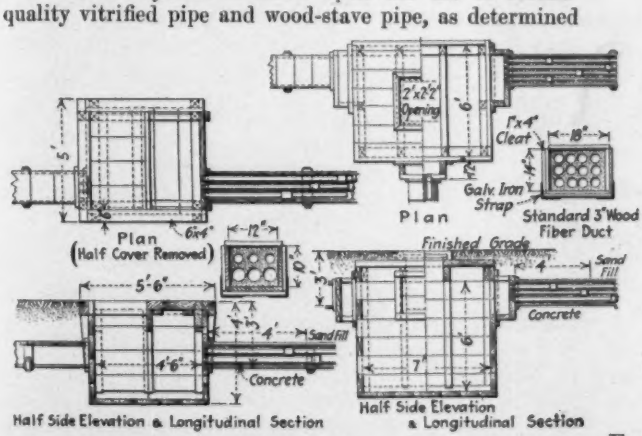


FIG. 4. CONDUIT AND MANHOLE CONSTRUCTION FOR THE UNDERGROUND ELECTRIC SYSTEM
(The construction at the left is used where ground-water is encountered. That at the right is used where no ground-water is encountered.)

To collect the storm water of the 63 acres of roof area of the main buildings the sewers are carried underneath all buildings, and receive the sheet-metal down spouts. Ordinarily, vitrified pipe is used under buildings, and in some cases is supported upon planks hung from the floor system.

In the determination of the amount of storm water to be considered in the computations of pipe sizes, the San Francisco rainfall rate curve was used. This curve gives a rate of 2.16 in. per hr. for a 5-min. interval, and 0.598 in. for a 60-min. interval. It was assumed that for a storm of a five-minute duration the runoff in the concessions district (paved roads, roofs and some yards) would be 70%; roofs of the main buildings, 100%; courts (paved roads and gardens), 60%; south gardens, 25%; main entrance (all paved areas), 100%. Further, the assumption was made, based upon a variable interval, that the runoff from the States and freight-pavilion districts would be 40%; stock exhibit, 70%; drill grounds and race track, 60%; and from the steep hillsides of the Presidio (south of the race track and drill grounds), 40%. The volume of sewage from the States and foreign section was taken as 20 gal. per min., from 70 buildings.

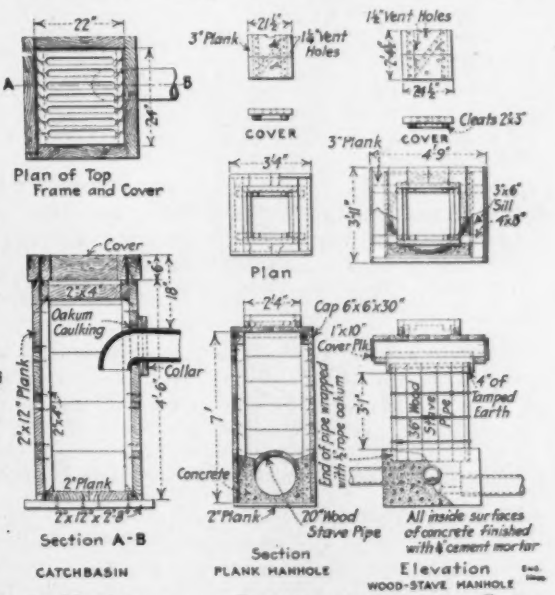


FIG. 5. MANHOLES AND CATCHBASINS FOR THE SEWER SYSTEM

In general the starting point of the hydraulic grade was taken at 7 ft. below city base, the mean of all high tides being 6.6. Where connections were made between

the exposition system and existing city sewers at a distance of 500 ft. or more from the main city outfall, the top of the trunk sewer at the point of connection was taken as the hydraulic grade point.

Toilet rooms and public lavatories are to be placed in convenient positions, and there will be public-comfort stations (with free and pay divisions) in all of the main buildings. There will be about 463 toilets and 278 wash basins for men, 400 toilets and 203 basins for women, 198 urinals, 63 slop sinks, 32 showers and 35 bath tubs.

The plumbing fixtures for these stations are to be installed by the holder of the lavatories and public-convenience concession, which is based on the idea that 33% of all toilets and urinals shall be free and a charge made for the others. This saves the exhibition about $25,000 for equipment. The toilet rooms, both free and pay, will be constructed in a substantial and sanitary manner, with walls of Keene's cement and floors of a non-absorbent plastic composition.

Plans for garbage disposal have not been settled definitely. The garbage may be collected under contract, and it is probable that it will be taken out to sea and dumped or taken to the incinerator now being built by the city in the southern part of San Francisco.

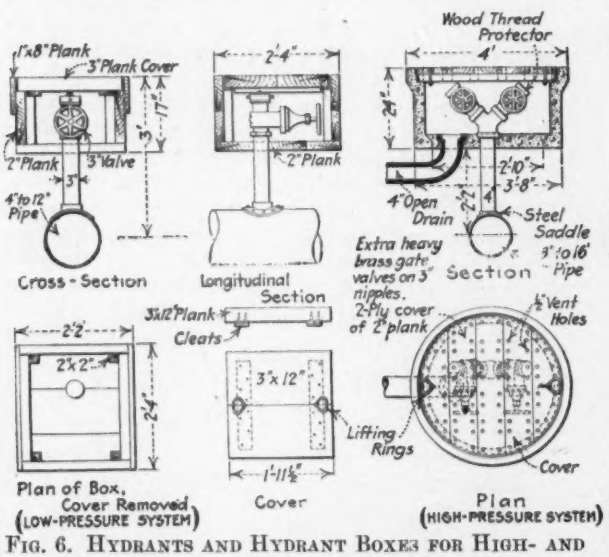


FIG. 6. HYDRANTS AND HYDRANT BOXES FOR HIGH- AND LOW-PRESSURE WATER-SUPPLY SYSTEMS; PANAMA-PACIFIC INTERNATIONAL EXPOSITION

(The box for the high-service hydrants is a concrete cylinder set in place, the concrete for the bottom being poured after the ring is in position.)

HIGH-PRESSURE FIRE-PROTECTION WATER SYSTEM

The high-pressure water system is designed to deliver 15,000 gal. per min. over an area of 100,000 sq.ft. under a running pressure of 200 lb. at hydrant, which pressure will be maintained in the most remote points of the main group. A higher pressure may be realized at points nearer the source of supply.

This system will be connected with the city's auxiliary water-supply system at two points on Van Ness Ave., and will be essentially a part of that system, obtaining its supply from the Twin Peaks reservoir (elevation 756 ft.). The highest and lowest ground elevation on the site are 82 ft. above and 2 ft. below datum. The system under normal conditions will be operated at an average static pressure of 200 lb. from the Ashbury Heights tank (elevation 462). Two fire-boat connections will be provided on the water-front, so that the two municipal fire-boats may pump salt water direct into the pipe system. The capacity of each boat is 10,000 gal. per min. at 150 lb. and 4500 gal. at 200 lb. Normally, however, the system will contain fresh water.

To avoid the unsightly appearance of hydrants, the system is planned for flush hydrants located directly over the mains. These hydrants are spaced approximately 300 ft. and have two 3-in. outlets with hose connections, as shown in Fig. 6.

The distributing system is composed of 6 to 16-in. lap-welded asphalt-dipped steel pipe with Dresser steel-sleeve couplings and extra-heavy cast-iron flange fittings, with the necessary gate valves to sectionalize the system (Fig. 7). All pipes and fittings will be subjected to a shop test of 500 lb. and a field test of 450 lb. Connections to each building from this system will be by means of 8-in. extra-heavy screw-joint pipe, one connection being provided on each of the four sides of every building. In this way a supply and perfect circulation will be assured for the floor and roof hydrants, the roof monitors and the automatic and cornice sprinkler systems.

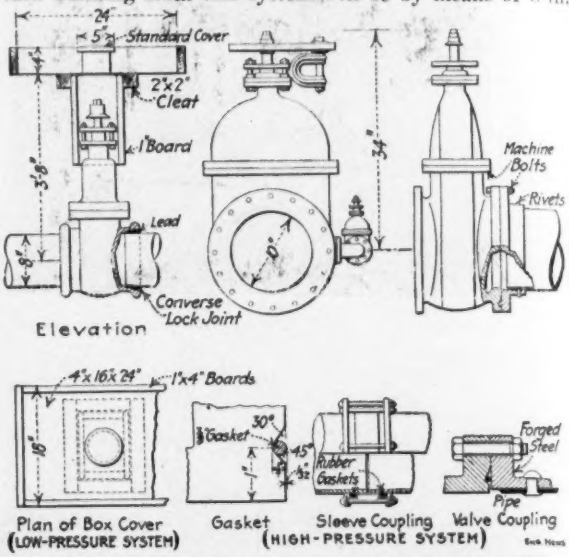


FIG. 7. GATE VALVES AND CONNECTIONS FOR THE HIGH- AND LOW-PRESSURE WATER-SUPPLY SYSTEMS

DOMESTIC WATER-SUPPLY SYSTEM

The maximum fresh-water demand is estimated to amount to 3,500,000 gal. per day, with a maximum rate of flow of 1½ times this amount. The fresh water will be furnished by the Spring Valley Water Co., probably from a neighboring reservoir (Francisco St.) at an elevation of 135 ft. Connections with the water company's mains will be made on Van Ness Ave., at the extreme eastern end of the concessions district. As the pressure available from this reservoir is insufficient, the plan contemplates the installation of a booster pumping station in the concessions district near Van Ness Ave., to establish not less than 50 lb. at the street curbs under normal conditions. In addition to this reservoir, it is planned (though not definitely) to make use of an existing 500-

000-gal. reservoir in the Presidio, which will be connected to the westerly side of the distributing system and will establish a constant pressure on the system.

The distributing system comprises 4 to 12-in. steel pipe. These mains will parallel those of the high-pressure water-supply system so that secondary and primary fire protection will be available in all parts of the districts covered with buildings. All pipes and fittings are coated with an asphalt composition which will afford sufficient protection for the time required.

All fire hydrants on this system are located directly over the mains and inclosed in wooden manholes, as shown in Fig. 6. They have outlets and are located approximately 400 ft. apart. Motor pumping engines of the exposition fire department will draw from the low-pressure hydrants as exigencies may require. The pipes are sufficiently large to permit of a draft of 3000 gal. per min. in this manner, in addition to that required for ordinary domestic purposes. The valve connections are shown in Fig. 7.

All main exhibit buildings will be connected to the domestic water-supply system by 6-in. pipes on each side of the building. From these will be supplied water for domestic service and to them will be attached the low-pressure stand-pipes and small-hose equipment. In all buildings, cross-connections between the high- and low-pressure water system will provide the automatic sprinkler systems with both primary and secondary supply.

Fire Protection

Acting with the advice of the Special Committee on Fire Prevention of the National Board of Fire Underwriters, special attention has been given to the matter of fire protection. The high-pressure and domestic water-supply systems will furnish primary and secondary fire protection respectively, as noted. The primary water-supply (for fire purposes only) will be available in the concessions, main exhibit buildings, and State and foreign districts. The secondary supply is to be provided throughout the grounds.

The endeavor has been made to keep all buildings separated by a distance not less than 130 ft., except where buildings (particularly in the main group) are joined by architectural connections. In the courts of the main group the requirements of the architecture were such as to demand a continuous facade around the several sides of the court. In such cases a fire-wall of reinforced concrete was interposed at the ends of the connections.

The plans contemplate a complete system of automatic sprinklers for all buildings of the main group. The detached buildings, however, will not be so equipped, as such protection was thought unnecessary, particularly in the case of the Machinery Palace, which is very high, and the Fine Arts Palace, which is fireproof. In addition to the automatic sprinklers there will be provided open cornice sprinklers for creating water curtains on the fronts of the buildings. These will be provided on all buildings where the distance between buildings is 150 ft. or less. Not being automatic, the control valves will be arranged in such a manner as to make them easily accessible.

All buildings will be equipped with 3-gal. chemical hand extinguishers, one for each 3200 sq.ft. of floor, and each exhibitor is required to supply one hand extinguisher for each 2500 sq.ft. occupied. Further, each main exhibit building will have at least one 33-gal. chemical fire-engine on wheels, equipped with 50 ft. of hose.

The primary and secondary water-supply will be brought within all of the main exhibit buildings. From the secondary system will be taken sufficient stand-pipes, to which will be attached equipments of 75 ft. of 1½-in. unlined linen hose, so that all parts of the floor area can be reached with at least one stream. From the primary system will be taken floor and roof hydrants and monitors. All high-pressure roof hydrants will be equipped with 150 ft. of 2½-in. cotton rubber-lined hose, which will be operated only by the exposition fire-department. Monitors will be installed in suitable positions on the roofs, so that 2-in. streams of water can be thrown inside and outside of the building and on neighboring buildings.

The exposition will provide a fully organized and equipped fire department, as well as an organization of guards to police the property. It is possible that the guards will be a special detail of U. S. troops. The plans contemplate at least three completely equipped fire-engine stations. All equipment will be motor-propelled, and will consist of three hose wagons, three motor pumping engines, one chemical engine, two ladder trucks, a squad wagon and a chief's car. The fire-alarm system will be provided with boxes conveniently located. All circuits will be carried underground to headquarters, from which alarms can be transmitted over separate circuits to various fire stations throughout the grounds. Connection will be provided with the city central office so that a general alarm can be transmitted in the event of a serious conflagration.

An automatic fire-alarm system will be installed in the main exhibit palaces, and probably this will be of the compensating thermostat type. Indicators and local bells will be placed on each building, with a transmitting device which will send alarms to the central fire-alarm office. A police signal system will be installed, with street boxes as required. The circuits will be carried underground to the police headquarters in the service buildings.

Roads and Pavements

Exclusive of the paths built by the States and governments, it is estimated that about 4,000,000 sq.ft. of pavement will be required, besides 700,000 sq.ft. in the formal courts and entrances.

The roads and pavements will be included in the color scheme, the color being realized by coloring the concrete and by using a red radiolarian chert (locally known as red-rock) for macadam roads. In the concessions district, a concrete or macadam base with a thin sheet of asphaltum will be used. In some parts where macadam is used it is probable that it will have an asphaltum or oil-wearing surface to accommodate the traffic conditions.

The avenues of most sections are from 50 to 80 ft. wide, the concessions street having a width of 80 ft. between curbs. Certain service roadways will be 20 ft. between curbs. Minor paths to the buildings and those forming part of the garden treatment and patrol paths are from 10 to 15 ft. wide.

In view of the temporary character of the work, the curbs for roadways and paths will generally be of 2-in. wood, varying in depth from 8 to 14 in., depending upon the character of the pavement. In special cases where

macadam is used without top surface, there will be box gutters on the steeper slopes to prevent erosion. The grades of the roads are nearly level. In the southwest portion of the site a maximum of 5% occurs.

About 16% of the road area is located over the hydraulic fill, but it is believed (and the settlement curves indicate) that all settlement will be reduced to a negligible amount by the time the road areas are ready for pavements. To prevent any possibility of local settlement, the base will be constructed of reinforced concrete.

To handle the construction traffic in connection with the building of the exposition there have been provided a number of temporary roadways composed of crushed concrete, brick and stone débris as obtained in clearing the site. This material has been laid directly upon the sand and roughly rolled and will later become the sub-base for the permanent roadways. For handling the lumber used in the construction of the buildings, there have been provided around each building, temporary roadways composed of 3-in. planks laid on 3-in. sills. These roadways are normally 16 ft. wide, over which horse-drawn two-wheel stevedoring trucks operate. All material of great weight or bulk will be handled over the railway tracks by means of steam locomotives.

Railway and Transportation Facilities

Provision has been made for ten miles of standard-gage track with about 70 switches, laid with 75-lb. rails. Tracks will be run into all main exhibit buildings, and unloading platforms installed. Steam locomotives will be maintained on the grounds to distribute all exhibits and freight. Terminal warehouse facilities are to be provided upon the grounds to the extent of 50,000 sq.ft.

A freight slip with a three-track apron will be built upon the water-front to receive the car-floats operated by the various railways which have terminals on San Francisco Bay, there being no direct railway connection. A ferry slip will be provided for the handling of the bay cities' passenger traffic. The slips are located at the eastern end of the north gardens, and have hydraulically operated aprons. They will be built on creosoted piles, and a stone breakwater projecting from the sea wall will break the heavy swells which at times prevail.

An existing basin at the west of the north gardens was surrounded on three sides with wharves to form the boat harbor for small boats. These wharves are on creosoted piles, and there are adequate stone breakwaters. The basin is 655x285 ft. Entrances will be arranged on the wharves, and it is expected that small steamers and motor boats will discharge visitors at these points. This harbor also furnishes berth space for the numerous lumber schooners during the construction period.

The Transportation Palace will have in its north half 15 exhibit tracks 500 ft. long. The railway equipment to be placed on exhibit will reach these tracks over a transfer table in the building. The table will be 75 ft. long with a run of 300 ft., and will be constructed to carry the largest locomotives (with tenders), and the largest cars. The table will be mounted upon 28 freight-car trucks (for 50-ton cars) and will be moved by motors. The transfer table and ten of the tracks in the building are designed for Cooper's E-60 loading, equivalent to 60,000 lb. on the driving axles; and five of the tracks for the E-30 loading, equivalent to 30,000 lb. per axle.

To facilitate the installation of heavy exhibits in the Machinery Palace there will be two 30-ton traveling cranes in the middle bay, with a 20-ton crane in each of the two principal side bays. All cranes will operate the full length of the building and will be equipped with 5-ton auxiliary hoists. Railway tracks will be put through the center of the building at right angles to the crane travel.

There will be no intramural railway system for the transportation of visitors, but the plans for transportation facilities have not yet been settled. Electric autobusses and electric wheel-chairs may be used.

*

An Early Objection to Wood-Block Pavements and an Early Argument for Timber Preservation

The following appeared in the London, England, *Herald*, of Oct. 23, 1841. How much influence such ideas as it expresses had on the subsequent universal use of preservatives for wood paving blocks, it would be interesting to know:

MR. EDITOR—There is one awful drawback which accompanies wood paving, and if it is not obviated before the consequences are impressed upon the public mind, it will be likely to create so strong a prejudice against its universal adoption, that the blocks already down may have to be taken up again through legislative interference, and the use of wood prohibited.

Wood runs so rapidly to decay when subjected to humidity, that the best seasoned timber exposed to damp soon becomes decomposed and putrescent. The albumen contained in it, like matter in animal substances, is a susceptible germ of rottenness, which starts into existence the moment the combined energies of wet and warmth reach it, and then its desolating influence spreads with a rapidity that nothing can reach or control.

Wood paving is not only acted upon by these two fertile sources of decay, but its fibers soon become impregnated with pestilential carburetted hydrogen, which exudes from gas pipes, saturates the surrounding earth, and being that very substance which escapes from animal and vegetable bodies in a highly putrefactive state, it will have a tendency to assist rapidly in the decomposition of the blocks.

Long before half the streets of this metropolis are covered with such a pavement, the "malaria" that will arise from so extensive a mass of vegetable corruption will sweep off the inhabitants more numerously and with more unerring certainty than the "plague of London," because every individual will be incessantly breathing the deadly venom floating in the poisoned atmosphere.

This is no imaginary theory. I have seen its deleterious and disastrous effects in those parts, where, from vegetable decomposition, human victims, thus infected, die like rotten sheep.

These lamentable results, can, however, be prevented by the blocks undergoing a previous preparation in a solution of "bichloride of mercury," which stops fermentation, renders the vegetable albumen insoluble, hard, antiputrescent, incorruptible, and therefore indestructible through the agency of decay.

Now this fact being no longer doubtful, parish boards will be neglecting a very sacred public duty if they do not in the future stipulate that all blocks shall be so prepared, not only to preserve the general health, but from motives of economy, as it is admitted that it increases their durability fourfold.

W. A. KENTISH.

London, Oct. 20, 1841.

This letter was reprinted with all seriousness, for the careful consideration of all American engineers contemplating wood-pavement installations, by the *American Railroad Journal*, of Dec. 15, 1841. We do not know whether the writer was an M. D., an engineer, or the publicity agent of an amalgamated association of manufacturers of bichloride of mercury, but at all events he was not far astray in his theory of timber preservation, even though his theories of disease were a bit fantastic.

Metal Flumes for Irrigation Canals

By F. W. Hanna*

In the construction of irrigation systems it is necessary to carry water across depressions in the ground surface that are so far below the normal canal grade as to make building of other than earth channels necessary. Where the depth of the depression is considerable, or where the available fall is ample, or where both of these conditions prevail, resort must be had, in the interests of economy, to the use of inverted siphons. Where, however, the depth of the depression is not too great for building a trestle to the grade line and where the amount of available fall is small, the most feasible structure for carrying the water across the depression is a flume.

The wood flume is always a very unsatisfactory kind of structure on account of the impossibility of making it water-tight, particularly after periods of non-use, but is usually cheap in first cost. Reinforced-concrete flumes

Figs. 1 and 2. Details of Joints and Supports of Metal Flumes

usually give good service, but the cost of forms used in their construction is, from the nature of such structures, an expensive item. Metal flumes are easily constructed, give satisfactory service and are not very expensive in first cost. The length of life of the different kinds of flumes mentioned would generally rank in the order of wood, metal and concrete; whereas in first cost the ranking would generally be in reverse order. Owing, therefore, to the ease of construction, their satisfactory service, and the relative cheapness of metal flumes, they have grown rapidly in favor in the last few years, and are being quite generally used for the more important structures in irrigation practice.

There are three general types of semicircular metal flumes in use in the irrigated regions of the United States: (1) the rough interior type (Lennon), in which the metal sheet of the flume is corrugated transversely to the axis of the flume at regular intervals of a few inches; (2) the semi-rough interior type (Maginnis), in which the general surface of the sheets is smooth, with small compression bands at the joints protruding into the water channel; (3) the smooth interior type (Hess), in which the inside surface is perfectly smooth. All are covered by patents.

Owing to the difference in the smoothness of the interior surfaces of the three types of flumes referred to, there is a difference in the value of n in Kutter's formula applicable to them. In their catalogs the manufacturers use 0.015 for the Lennon and Maginnis types and 0.012 for the Hess. So far as the writer knows, there have been no experiments made by the Reclamation Service for determining the value of n for the Lennon flumes. Several measurements on the Boise project on Maginnis flumes gave the average value of n as 0.0157; like tests on the Hess and other smooth interior flumes gave a value of 0.0116. While these values of n are about what would be expected, the number of experiments was insufficient to be conclusive.

In all three types of flume, the trough is made of galvanized sheets of steel or some special corrosion-resisting metal, in widths sufficient to make the semicircular section of the flume, and in lengths of about 30 in. for the larger flumes and greater for the smaller ones. In forming the union of these sheets the joints are made by lapping corrugated portions of the sheets, encircling the lap with a carrying rod and placing a compression bar on the inside of the lap (Fig. 1). The encircling carrying rod is threaded on both ends and provided with nuts, and the ends of the compression bar are fitted with shoes, or the ends of the bar are turned out at right angles to form such shoes, which are bored for the insertion of the ends of carrying rods. When the joint parts are assembled the tightening of the nuts on the carrying rods secures a high degree of compression of the lapping sheets. The details of the corrugation and shapes of the compression bars are different in the different designs, and lend themselves differently to perfection of joints. In the smaller Lennon flumes the shoes are made to extend over the stringers as carriers for the flumes, but in the larger Lennon flumes and in the Maginnis and Hess flumes, the carrier rods are brought up through carrier beams and held with washers and nuts (Fig. 2). The carrier beams extend far enough laterally to support the flume on the stringers. The stringers are supported on suitably braced trestles at economical intervals, based on mud sills or on concrete pedestals. Flume sections for curved alignments are made by the manufacturers. The curvature is taken up equally at each joint of the flume on the curve, or is concentrated in the lapping sections at the joints at the ends of the stringers, thus making the flume a series of short chords. The latter plan is much more satisfactory from the erection viewpoint, and gives an efficient structure.

In the construction of the flumes, the pedestals are placed and their tops carefully brought to determined elevations, so that the trestle posts can be cut to the proper lengths, and the bents can be framed on the ground. The bents are then raised and bolted on the pedestals, the stringers fastened into position on them and the longitudinal bracing put on. In the smaller flumes it is advantageous to put several sections of the trough together and install them as a unit on the stringers. In the larger flumes one section is generally raised and put into place at a time. In fitting the sections together, it is desirable to paint them at the joints, and also the rods and bars to secure water-tightness and prevent corrosion. Care should also be exercised to match the sections accurately, in order to maintain true alignment of the trough, with grade and trestle.

Up to June 30, 1913, the Reclamation Service had constructed 248 metal flumes, with a total length of 74,668 lin.ft. Of these metal flumes, there were constructed, under the general supervision of the writer, on the Boise project, 63, having a total length of 37,648 lin.ft.

Inasmuch as the manufacturers have, to a large extent, determined the general methods of timber and concrete work in connection with metal-flume construction,

*Engineer, U. S. Reclamation Service, Washington, D. C.

much the same general designs are used by all irrigation engineers. A description of the methods used on the Boise project will, therefore, in a general way, be indicative of the common practice.

In the construction of all of the flumes on the Boise project concrete pedestals were provided having square or rectangular tops to suit the dimensions of the posts. The pedestals are battered on all sides about 1 in 9, and vary in height generally from 2¼ to 3 ft., a few inches of which are above the ground. These dimensions were varied to suit local conditions where soils of unusual character were encountered. The posts of the trestles are attached to the pedestals by means of strap irons provided with bolt holes for bolting them to the posts, and with right-angle turns at the lower ends for anchoring them in the concrete, in which they are imbedded to a depth of about 9 to 11 in. The dimensions of the strap iron used are ⅜x2x21 in.

Stringers varying to suit economical conditions from 16 to 20 ft. in length were used for supporting the metal tures, when the bents exceeded 18 ft. in height, [illegible] adjacent spans were braced instead of alternate spans and the next succeeding span was left unbraced; although this plan was not generally followed. The posts were generally given a batter of either 1 in 6 or 1 in 8 from the stringers to the pedestals to assist in giving lateral rigidity. The stringers were supported on the posts, and were provided with struts joining the posts and the stringers each at an angle of approximately 45 degrees. Fig. 3 shows a side view of a flume of 100 sec.-ft. capacity.

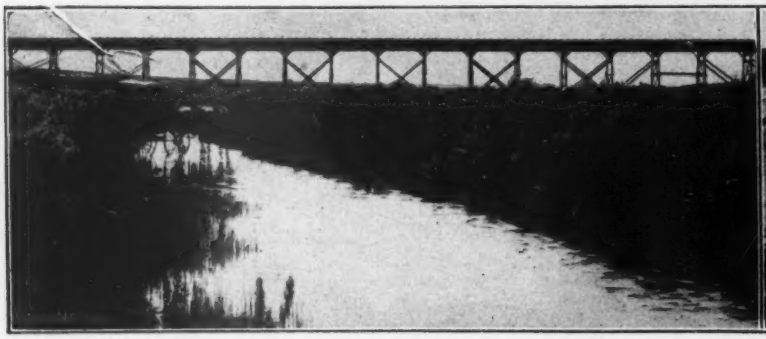
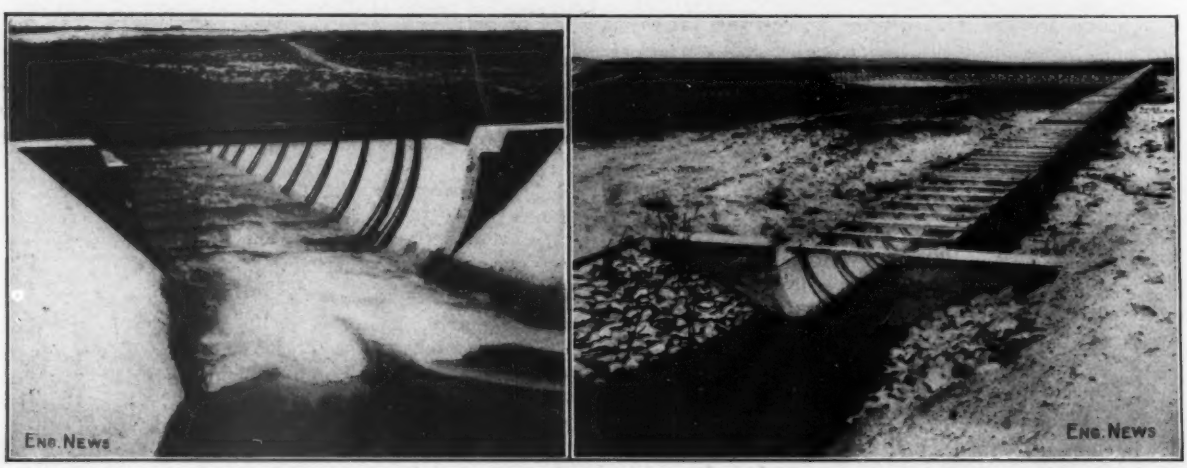


FIG. 3. SIDE VIEW OF FLUME OF 100 SEC.-FT. CAPACITY, BOISE PROJECT

FIG. 4. INLET TO FLUME OF 17 SEC.-FT. CAPACITY, BOISE PROJECT

In all of the flumes, reinforced-concrete inlets and outlets were constructed. In the smaller flumes the inlets and outlets are similar and consist of a transverse headwall, with return walls at right angles extending into the canal banks. Fig. 4 shows clearly the inlet of a flume of 17 sec.-ft. capacity. The area between the wingwalls was usually riprapped with boulders and grouted. In the larger flumes the inlet consists of a transverse headwall with flaring wingwalls extending into the canal banks



FIGS. 5 AND 6. INLET TO AND OUTLET FROM FLUME HAVING 100 SEC.-FT. CAPACITY, BOISE PROJECT

body of the flume on trestles. Cross timbers to which the flume is bolted rest on these stringers. All of the trestles are cross-braced to furnish lateral rigidity. The spans are not generally provided with longitudinal bracing between the posts for bents of less than from 10 to 12 ft. in height, but for trestle heights between 12 and 18 ft., alternate spans were braced. On some of the structures at angles of approximately 30 degrees with the axis of the flumes, and in some cases warped to reduce the entrance head. The area between the wingwalls and the headwalls of the inlet was provided with a concrete floor, and the area between the wingwalls and the headwall of the outlet was provided with a grouted boulder riprap floor. Fig. 5 shows the inlet of a flume of 100

sec.-ft. capacity; and Fig. 6 shows the outlet of the same flume. In some special cases where the soil was extremely sandy and liable to permit excessive seepage, the area between the outlet walls was also provided with a concrete floor. The first and last section of the metallic flume were cut into for about 9 in. parallel to the axis of the flume at intervals of 3 to 6 in., and the pieces between the cuts bent backward at right angles to the flume surface and embedded in the headwalls.

In all cases an expansion joint was provided at the inlet or the outlet, or at both, in long flumes, which in the Maginnis type was made by riveting to a section of the flume a strip of sheet iron about 9 in. wide, similar to that of the fluming, with a filler between them. The adjacent corrugation of the succeeding section of flume was sheared off, and the section was inserted between these two pieces to form the joint. One of the regular outside supporting rods was run around the joint. The weight of the water compresses the strips of metal together onto the rod, making the joint water-tight, and at the same time permitting slipping between them in case of a longitudinal force. The Hess flumes are provided with a patent flexible expansion joint, one of which is used for about every 300 to 400 ft. of flume length.

The metal sheets of the flumes are all galvanized to prevent rust and corrosion. Four years of service on the Boise Project shows the galvanizing to be in good condition and practically no rusting of the body of the sheets. On one of the projects of the Reclamation Service some rusting of consequence has occurred where the sheets were made of ordinary steel or iron, but not where they were made of a special rust-resisting product. Undoubtedly, the use of a rust-resisting, anti-corrosive body out of which to form the sheets as well as galvanizing them is important; but none of the flumes of the Reclamation Service have been in use long enough to determine the excess of life to be obtained from the use of these specially prepared products over that for ordinary iron or steel.

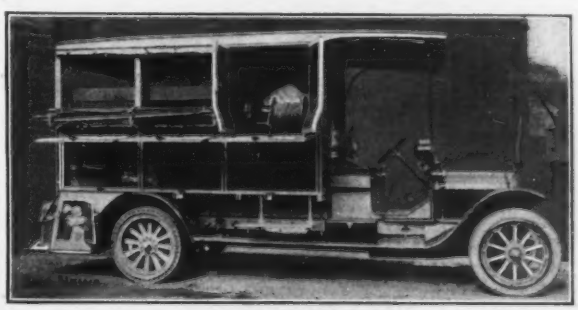
There has been very little difficulty experienced in keeping the regular joints of the metal sheets water-tight on the Boise project, or elsewhere in the Service. It is necessary at intervals to go over each flume and tighten the nuts on the carrying rods at a few of the joints, but this need is small. In some instances sheets are furnished in which there are welded or riveted joints. These joints give trouble from leakage, and sheets containing them should not be used.

In order to give extra capacity in cases of accidental surplus water in the canals, to avoid over-slopping from wind action and to permit passage of trash under the carriers when carriers are used instead of hangers, a clearance of from 2 in. on small flumes to 6 in. on large ones, with proportionate values for intervening sizes, was provided in the flumes on the Boise project. Obviously in small flumes where the metal trough may be supported on the stringers with hangers the trash problem is eliminated. Clearance is a matter of importance that is sometimes overlooked in estimating the capacity of a flume, resulting in the installation of a structure of too little capacity. Unless drop is provided in the canal at the flume entrance, it is also advisable, where the flume velocity is greater than the canal velocity, to put in from 10 to 15 ft. of flume of larger size to provide extra depth where the velocity is being accelerated.

The limiting of the maximum velocity in metal flumes, where there is considerable sand or silt in the water, is necessary to prevent cutting the metal. Good results have obtained where velocities of not over 5 or 6 ft. have been used. The installation of a sand trap in the canal immediately adjacent to the inlet of the flume will afford considerable protection against erosion from high velocities. In real sandy areas this device is of service also in preventing the flume from filling partly full of sand when being operated at less than full capacity.

A Motor Vehicle for Relief Work at Mines

A motor truck for relief work following mine accidents, has been built by the White Co., of Cleveland, Ohio, to specifications of the U. S. Bureau of Mines, and delivered to the Bureau in Pittsburgh, Penn. The vehicle shown in the illustration is a veritable moving emergency hospital. Included in its equipments are two pulmotors, six oxygen tanks, 50 regenerators, an oxygen pump operated by the truck motor, two stretchers, a life line, box of explosives, lanterns, tents, fire extinguishers, telephone system, 20-ft. hose, tools, and medical and surgical supplies. Even a cage of birds for use to determine the presence of poisonous gases is provided. The interior of the vehicle is arranged in compartments, and every article has a special place, so that it can be found immediately when required.



A Motor Truck for Mine-Rescue Work

Two recent great mine disasters have emphasized the need of apliances and methods to afford prompt rescue. On Oct. 4 the day shift of the Universal Colliery at Senghenybd, Glamorganshire, Wales, which comprises 935 men, was entombed after an explosion. Of this number 489 were rescued, leaving a death list of 434 men. On Oct. 22 an explosion occurred in Coal Mine 2 of the Stag Cañon Fuel Co., located at Dawson, N. M., and resulted in the death of 263 men.

Increased Water Supply for Zürich, Switzerland, is to be provided by a new intake extended out into the lake beyond the present intake and to a greater depth, and a new filter plant. The present supply is furnished by a spring-water supply of a capacity of 6½ million gallons per day and a lake-water supply of practically equal capacity, with filters. The lake intake is 42 ft. deep. The new intake is to be at a depth of 80 ft. about ¼ mi. off Wollishofen, where the lake is 175 ft. deep; a purer supply is obtained here, and the water carries very little plankton. The intake and pumps are to be built of a capacity of 28 million gallons per day, one-half of which capacity will be built first. The total water supply (including spring-water supply) will be adequate for a population of 400,000. The new filters will include preliminary and finishing filters, slow-sand-filtration being used for the finishing process. ("Schweizerische Bauzeitung," Oct. 11, 1913.)

Instructions to Field Parties for the Subsurface Survey of Cincinnati, Ohio

For nearly two years the city of Cincinnati, Ohio, has been undergoing a thorough sewerage investigation, the primary object of which is to obtain the requisite data for extensive improvements to the sewerage system and for the establishment of sewage-disposal works. Of this work, Harrison P. Eddy, of Metcalf & Eddy, Boston, Mass., is Consulting Engineer; H. M. Waite is Chief Engineer of the Engineering Department of the City of Cincinnati, and H. S. Morse is Engineer in Charge of the Division of Sewerage Investigation, under whose supervision the work described below is done. The topographic survey of the city described in our issue of Apr. 3, 1913, is a part of the same investigation.

Field work on the underground survey was started in April, 1912, and, it is expected, will be completed at the close of the present year. It is estimated that the work includes the location of some 500 miles of sewers. During the past summer eight parties of four men each and 12 draftsmen have been kept busy on this work. The original records of the survey will comprise more than 1000 sheets 24x36 in. The cost of the field work to Oct. 1 had averaged $60.54 per mile, and the cost of platting $44.34 per mile. The work of the underground survey is under the immediate supervision of O. E. Carr, Assistant Engineer.

The work of the Division of Sewerage Investigation, of which Mr. Morse is in charge, includes topographic mapping, underground survey, design of relief sewers, intercepting sewers and studies for sewage disposal. Instructions to underground field parties for collecting data were drawn by Mr. Morse and have been amended from time to time as experience dictated. The reprint of these instructions given below will prove of great value to city engineers who are about to undertake similar work.

PURPOSE OF THE SURVEY

The purpose of the underground survey is to obtain data from which to make plats of streets to show all underground objects in the streets. These plats will be used primarily as a basis for all the future sewer location and design. They will be made on a scale of 1 in. = 40 ft. in the congested section of the city and on a scale of 1 in. = 50 ft. in all other sections.

The notes obtained in the field will be plotted on brown paper from which tracings will be made. From the tracings cloth white prints will be made and these white prints will be bound in book form of the loose-leaf type, to be kept as permanent records.

If the chiefs of parties will keep the object of this survey in mind, the results shown in the field notes will be much more intelligible to the draftsmen in the office and added interest and value will be given to the work in the field.

DATA TO BE OBTAINED

(1) STREETS:
- Curb lines.
- Property lines.
- Width of streets and alleys.
- Width of roadways.
- Distance between property line and curb, both sides of street, where possible.
- Kinds of pavement.
- Elevation of street at summits, hollows and grade changes on sewer center line.

(2) SEWERS:
- Center line.
- Manholes:
  - Location.
  - Elevation of top.
  - Depth.
  - Diameter, top and bottom.
  - Shape.
- Sizes.
- Material of construction.
- Flush tanks.
- Flushing manholes.
- Lamp holes.
- Outlet structures.
- Special structures.
- Depth of flow, and time of day when taken.
- Condition.
- Type :
  - Sanitary.
  - Storm.
  - Combined.
  - Intercepter.
  - Relief, sanitary, storm or combined.
- Open channels for sewage.

(3) WATER PIPES. (4) GAS PIPES. (5) ELECTRIC CONDUITS. (6) TELEGRAPH CONDUITS. (7) TELEPHONE CONDUITS. (8) ELECTRIC RAILWAY TRACKS. (9) STEAM RAILWAY TRACKS. (10) FIRE HYDRANTS. (11) FIRE CISTERNS. (12) CULVERTS. (13) BRIDGES. (14) LOCATE ALL GOVERNMENT, CITY AND COUNTY PROPERTY.

ACCURACY REQUIRED—The degree of accuracy required in horizontal chaining measurements will be 1 in 10,000. In a block length of 400 ft. this means that 0.04 ft. variation between the two measured lengths will be allowed or 0.01 ft. in 100 ft.

Tape measurements, as in manholes, shall be made to the nearest 0.01 ft.

Elevations on manholes shall be taken to the nearest 0.01 ft. and the street surface to the nearest 0.1 ft.

Level circuits shall be closed within the following limit: $0.05\sqrt{M}$; where M equals the distance in miles over which levels are run.

TRAVERSE LINES—A traverse line shall be run on each street either on the curbing, sewer center line or where conditions of each case indicate best. From this traverse line all objects required shall be located.

STREETS

From the traverse line locate the curbing, property lines and intersections. Measure the width of roadways, width of streets and alleys between property lines, and the distance between property lines and curbing on both sides of the street where possible. Measure each of these distances. For instance, do not measure distances between property lines and the distance between curbs, subtracting the latter from the first and dividing by 2 to obtain the distance between property lines and curbing. Measure each of these distances. Measure the angle of intersecting streets.

By levels secure the elevation above sea-level datum of summits, hollows and marked changes in grade of the street over the center line of the sewer. Other than these points no profile levels shall be run. Therefore these elevation points should be so selected as to indicate approximately the profile of the street.

If the street is improved note the kind of pavement; if unimproved record this fact.

Locate all streets used for traffic, whether sewered or not.

SEWERS

CENTER LINE—From the traverse line locate the sewer center line; ordinarily the line from center to center of manholes shall be accepted as the center line of the sewer; but it should be borne in mind that manholes are seldom on the exact center line of the sewer, and in some instances are purposely offset and constructed on the side of the sewer. Therefore, the sewer center line and the line center to center of manholes seldom coincide; if the deviation is small these lines will be considered as coinciding. If there is much deviation this condition should be recognized in locating the sewer center line.

MANHOLES—Manholes shall be located from the traverse line and an elevation to 0.01 ft. shall be taken on the rim of the manhole casting on the downstream edge of the manhole.

The depth of the manhole shall be measured. This measurement shall be taken from the downstream edge of rim of casting to the invert of the sewer. Particular care shall be exercised in taking this measurement to have the tape or rod held plumb and to be sure that the true sewer invert is reached. If a deposit is found in the sewer bottom, remove this deposit so this measurement can be made accurately.

If a difference of elevation exists between the invert of the sewer entering the manhole and invert of the sewer leaving the manhole, note this difference.

On the record plat the elevation of the sewer invert and depth of the manhole will be recorded and not the elevation of the top of the manhole. This is done because the sewer invert is fixed, whereas the street elevations may change. Therefore, insert the elevation of the sewer invert at the manhole in the field notes.

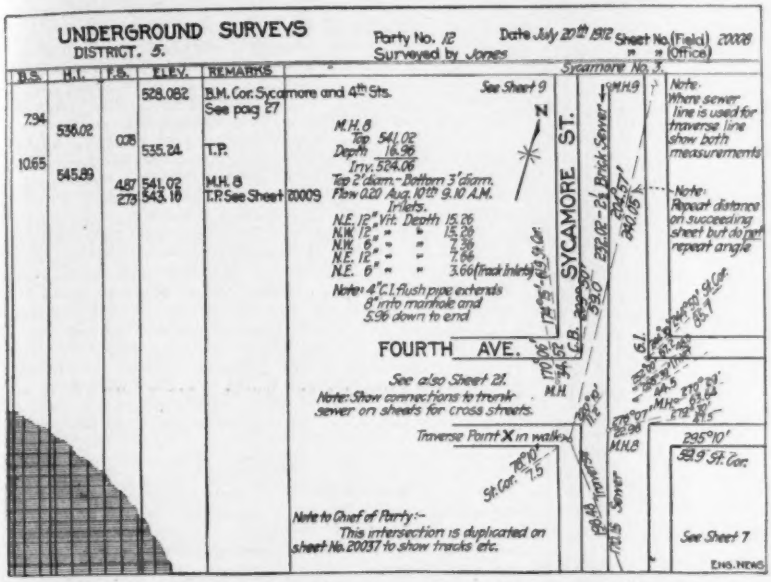

UNDERGROUND SURVEYS
DISTRICT. 5.
Party No. 12 Date July 20th 1912 Sheet No.(Field) 20038
Surveyed by Jones " " (Office)
B.S. H.I. F.S. ELEV. REMARKS
528.082 B.M. Cor. Sycamore and 4th Sts.
See page 27
7.94 536.02 008 535.24 T.P.
10.65 545.89 487 541.02 M.H. B
273 543.16 T.P. See Sheet 20009
M.H. B
Top 541.02
Depth 16.96
Inv. 524.06
Top 2' diam. - Bottom 3' diam.
Flow 0.20 Aug. 10th 9.10 A.M.
Inlets.
N.E. 12" Vit. Depth 15.26
N.W. 12" " " 15.26
N.W. 6" " " 7.36
N.E. 12" " " 7.66
N.E. 6" " " 3.66 (track inlet)
Note: 4" C.I. flush pipe extends 8" into manhole and 5.96 down to end
See Sheet 9
Sycamore No. 3
SYCAMORE ST.
M.H. 9
Brick Sewer
Note: Where sewer line is used for traverse line show both measurements
Note: Repeat distance on succeeding sheet but do not repeat angle
FOURTH AVE.
See also Sheet 21.
Note: Show connections to trunk sewer on sheets for cross streets.
Traverse Point X in walk
295°10'
52.9 St. Cor.
See Sheet 7
Note to Chief of Party:-
This intersection is duplicated on sheet No. 20037 to show tracks etc.
ENG. NEWS

FIG. 1. SAMPLE PAGE OF FIELD NOTES ON LOOSE LEAVES OF CROSS-SECTION PAPER, 8½x10¾ IN.

The diameter of the manhole at top and bottom shall be measured. Note wherever the manhole is a junction, summit or intermediate manhole and the shape, i.e., oval, round, etc.

Locate and measure all pipes passing through or leading into manholes, noting their classification, as water pipes, gas pipes, catch-basins, inlets, etc. In locating such pipes, note the distance from the invert of the pipe to the invert of the sewer and the position with relation to the center of the manhole.

Note the shape of manhole cover, i.e., square, round, etc., and the kind of cover, i.e., closed, perforated, grating, etc.

Note whether any flushing pipes are connected with manholes, obtaining their sizes and locations.

SIZES OF SEWERS — Measure both horizontal and vertical diameters of sewers at outlet, manholes and wherever a change of size is found.

MATERIAL OF CONSTRUCTION—Note the material of which the sewer is constructed, as vitrified pipe, brick, concrete or stone. Note also especially the material of which the invert of the sewer is constructed, as for instance, if a brick or concrete sewer, whether the invert is of vitrified brick, cut stone, concrete or channel pipe.

FLUSH TANKS — Note location of flush tanks, and the type and condition.

FLUSHING MANHOLES—Note location of flushing manholes, and the type and condition.

LAMP HOLES—Note location of lamp holes, and the size and depth to the sewer inverts.

OUTLET STRUCTURES—Make a sketch showing dimensions of outlet structures. Note material of which they are constructed and the condition of this material. Also obtain the distance from outlet to the main channel into which the sewer discharges, noting particularly the sanitary conditions around all outlet structures.

SPECIAL STRUCTURES—Locate and show by sketches the details of all special structures, as junction chambers, overflows, drops and inlets. By inlets, in this instance, openings for steam drainage are meant and not gutter inlets.

DEPTH OF FLOW—At the time measurements are taken at outlet structures or at manholes measure the depth of flow in the sewer and record the time of day at which this measurement is taken.

CONDITION—Particular attention shall be given to the condition of the sewer, both from the structural and sanitary standpoint. Note whether the sewer is in first-class condition structurally or whether repairs are needed. For instance, it is reported that there are sewers in the city in which the inverts are either worn out or washed out. All such cases should be carefully examined and reported. Also note the condition of the sewer as to indications of stoppage or flooding. Deposits on sides of manholes frequently indicate flooding conditions.

TYPE OF SEWERS—Note the type of sewer, as whether it is a sanitary sewer carrying house drainage only; a storm sewer carrying storm drainage only, either from the streets or from down spouts from houses; a combined sewer carrying both storm and sanitary sewage; an intercepting sewer, i.e., a sewer intercepting the flow from several trunk sewers in order to convey it to some particular point; and relief sewers, i.e., sewers constructed to relieve sewers which have proven inadequate. In many instances it will be found difficult to distinguish the exact type of sewer, for sanitary sewage frequently is found in storm sewers and down spouts are often connected to sanitary sewers. However, an effort should be made in every case to determine the type of sewer.

OPEN CHANNELS FOR SEWAGE—Open channels for sewage should be located and dimensions noted.

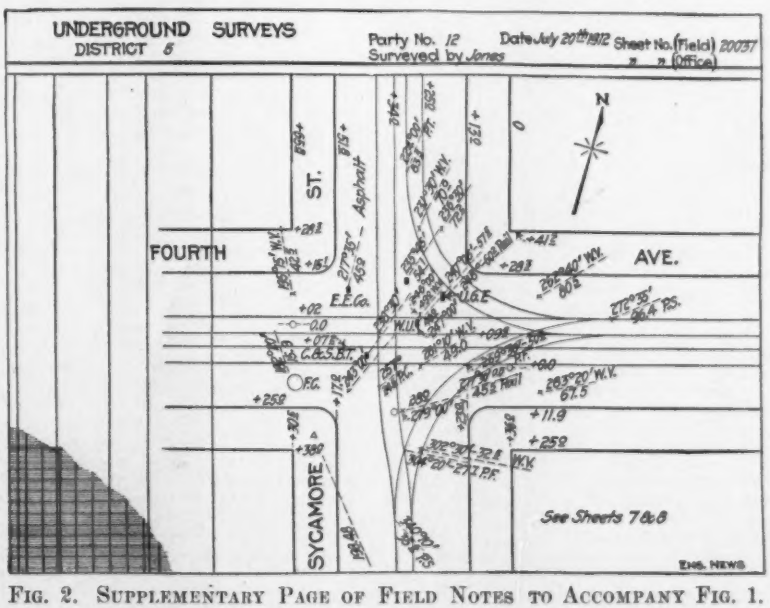


FIG. 2. SUPPLEMENTARY PAGE OF FIELD NOTES TO ACCOMPANY FIG. 1.

Locate all sewers whether in streets or not.

OTHER STRUCTURES

WATER PIPES, GAS PIPES, ELECTRIC CONDUITS, TELEGRAPH CONDUITS AND TELEPHONE CONDIUTS—Locate to the nearest 0.1 ft. the surface indications of the above pipes or conduits, as for instance, manholes, main valves, etc.

Do not locate individual service valves.

Access to the records of the concerns controlling these conduits has been obtained so that they can be plotted on record plats but the above information as to surface structures is necessary to check these office records.

ELECTRIC RAILWAY AND STEAM RAILWAY TRACKS.

—Locate the electric railway and steam railway tracks excepting in yards, where it will be sufficient to locate the outside tracks.

FIRE HYDRANTS AND FIRE CISTERNS—Locate all fire hydrants and fire cisterns. It is not necessary to secure the dimensions of fire cisterns.

CULVERTS—Locate and obtain dimensions of all culverts passing under streets.

BRIDGES—Locate and note the types of all bridges.

FIELD NOTES

Three field books shall be kept:

(1) A loose-leaf book showing all locations, measurements and profile-level notes.

(2) A bench-level notebook.

(3) A diary and memorandum book.

The accompanying sample sheet Fig. 1 (actual size 8½ x 10¾ in.) of a loose-leaf notebook shows the relative positions of sketch, level notes, etc. The sketch shall be drawn on a scale of 1 ft. = 50 ft. using the cross-section lines on the paper for this purpose.

Bench-level notes shall be kept in a separate book. Profile-level notes are shown on the regular loose-leaf sheets, but frequently it is necessary to run bench-level circuits, and these notes shall be kept carefully, noting the benchmark locations and descriptions and the errors of closure. A copy of notes of bench-level circuits shall be sent to office as soon as line is run.

A diary and memorandum book shall be kept as a journal making daily entries as to location of party and progress made; but particularly as to any defects discovered in sewer construction, obstructions in any sewers or inlets, unsanitary conditions requiring remedy, complaints or facts as to flooding, odors, or lack of drainage facilities and location of laundries, slaughter houses, ice factories or other establishments discharging a large quantity of sewage.

The party chiefs are in positions to make these notes of great value. They should realize that their duties are not confined to location surveys, but embrace the investigation of sewerage conditions. The notes contained in these books will be used in the study of sewerage conditions and the design of relief sewers.

Neatness, thoroughness, accuracy and honesty are requisite to the keeping of good field notes. Be certain that field notes are complete before sending them into the office. If any additional information or corrections are placed on any sheet after it leaves the field, such additions or corrections shall be made in red ink and shall be initialed by the person making them.

INSTRUMENTS

Chiefs of parties shall be held responsible for all instruments or other equipment used by their parties. If practicable, instruments shall be left at the main office each evening. Usually this is impracticable. Therefore, in such instances effort shall be made to leave instruments at police stations, fire-department houses or other public buildings where they will be safe.

DAILY REPORTS

Reports shall be made to the office daily on cards similar to attached copy (Fig. 3). These cards are kept on file to be used in computing the cost of the work and are used weekly in estimating the progress made by each party. These reports should be made carefully and neatly and should be sent into the office promptly each day.

SUPPLEMENTARY INSTRUCTIONS

These additional instructions have been issued in order that the existing instructions may be more rigidly enforced and at the same time establish methods which will facilitate the survey work.

Hereafter each party will be assigned to some portion of a drainage district and this must be entirely completed before another assignment is made. With each assignment the chief of party will be given the necessary field sheets, together with two or more precise-level benchmarks. The order of procedure for completing the work shall be as follows:

(1) Establish additional benchmarks throughout the assignment.

(2) Surface location from traverse points and lines, and all traverses run to closures.

(3) Sewer investigations at outlets, manholes, catch basins, etc.

(4) Levels over manhole tops.

Each of these operations must be done with the party in charge of its chief, that is, no part of this work shall be done without the chief of party being present.

BENCH-LEVEL CIRCUITS—Before taking up the work of location in an assignment, bench-level circuits must be run about the assignment leaving sufficient benchmarks for checking level circuits over manholes. These bench-level circuits must be run through at least two previously established benchmarks, preferably precise-level benchmarks, and these level circuits closed. Rod readings on bench-level circuits are to be read to thousandths, on manhole circuits to hundredths of a foot.

The level notes for the bench-level circuits are to be kept in the duplicating level notebook. When the circuits have been completed for the assignment the original notes will be sent to the main office and copies held by the chief of party.

While these bench-level circuits are being run the chief of party will send one or two rodmen, with a pick and the sewer plat, over each street in the assignment to note if there are any manholes which cannot be found. These manholes which they fail to find should be noted and reported at once to the main office with sufficient description to enable additional data being secured from the records.

LOCATION SURVEYS—Unless otherwise instructed it will be found preferable to complete the traverses and location about the outer limits of the assignments, then traverse and locate the parallel streets in one direction and finally the streets running in other directions. Each traverse must be closed, that is, the angle at each of the two closing points must be recorded as well as the distance between them. Confine the location work to but one street at a time.

At street intersections record angle to nearest manhole at each end of cross streets from which traverse will later be closed. Next complete the location of all topography which is confined within the street lines upon which the traverse is

WEATHER	DAILY REPORT	DATE
Cloudy Rain 3-5	DIVISION OF SEWERAGE INVESTIGATIONS, DESIGNS AND PLANS	June 30 PARTY No. 12

KIND OF INVESTIGATION: Underground Surveys

DISTRICT	WORKING ON	FROM	TO
Cummins-ville	Rejones Line Levels	B.M.H. Fergus	M.H.'s Mad Apthony St.
	NAMES	NOW EMPLOYED	HOURS
	Chase	Hamilton	Done 201 St.
	Lingo	Fergus	$90.00
	John Jones	Measuring Line & MH	6
	R.J. Roe	" " "	6
	W.J. Coe	" " "	6
	M.J. Tope	Levels on M.H	6
	P.S. Cole	" " "	6

EXPENSES

REMARKS: Lost 2 hrs account of rain.

(Do not sign here) ENGINEER IN CHARGE

FIG. 3. DAILY REPORT CARD (½ ACTUAL SIZE)

being run. Do not duplicate the location of topography at street intersections when traversing the cross streets.

All lines and topography shall be located direct from traverse points by the "angle and distance method." Wherever possible the sewer line must be used for the traverse line and the centers of manhole covers as traverse points. In which case all distances between manholes shall be measured both forward and back and both measurements be recorded. (Double distances measured only on main or boundary traverse.)

When street cars or traffic interfere with the occupying of manholes, traverse points shall be so selected as best suits conditions, but preferably opposite manholes. In this case measure traverse lines and sewer line each once. For the method of recording field notes see sample field sheets, Figs. 1 and 2. At congested street intersections locate and record on the field sheets, which have the street and curb lines indicated upon them.

(1) The data pertaining to sewers such as: Location of street and curb lines, corners, etc.; sewer center line; manholes; inlets and catch basins; levels.

(2) If there are car tracks in the street or other data to be obtained which would crowd this first sheet, show on an additional sheet on enlarged scale the following: (1) Traverse lines and points; (2) curb lines; (3) water gates; (4) gas gates; (5) conduits, tracks, bridges and all such information as required, but not pertaining directly to sewers (see Fig. 2).

At all manholes, offsets must be taken by continuous measurement from the manhole to car tracks, curbs and streets lines.

As far as possible each field sheet must be completed as fast as the work progresses.

When all the streets in an assignment have been traversed a sketch shall be made, showing each and every traverse line with the recorded angles and distances shown in their relative position. This sketch must accompany the field sheets when these are turned in as complete.

SEWER INVESTIGATION AT OUTLETS, MANHOLES, INLETS, ETC.—The investigation of sewers is a vitally important part of this survey and the chief of party should not leave any such point of investigation until he is satisfied that he has secured and recorded all the information required or made adequate explanations on the field sheet why such information could not be secured.

While this investigation at manholes is being made the chief of party should examine each field sheet carefully to see that all data is clear and complete as regards location and investigation.

A daily record of defective sewerage complaints, etc., should be kept in a pocket notebook and a written report of these facts made each week. This report is to accompany the regular weekly report, as hereafter provided for.

LEVELS OVER MANHOLE TOPS—Under no circumstances must levels be taken at manholes until the bench-level circuits have been run and properly reported from the main office as being sufficiently correct. Do not establish new benchmarks or manhole-level circuits, but run all levels to and from benchmarks established on bench-level circuits. Should any errors be found in levels do not erase the original notes, simply draw a fine line through the incorrect notes and place the correct figures close by.

When the levels have been taken on manholes each field sheet should then be complete in every respect and ready to be sent in with the weekly report. After having covered each street at three different times it is expected that the field sheet will be complete.

FIELD SHEETS—Chiefs of party are cautioned against using a field sheet unless previously numbered. Each party chief will be given all the field sheets necessary for his assignment, but each sheet will be charged to him. When these field sheets are returned to the main office he shall account for each and every sheet whether used or mutilated and whether of any apparent value or not.

No field sheet shall be copied unless instructed to do in writing from the engineer in charge.

REPORTS

Besides the daily reports called for by the original instructions each chief of party will make a weekly report showing the number of feet of sewer surveyed during the week. A copy of each weekly report shall be kept by the chief of party in order to avoid reporting as work done during the week, any work which has been previously reported.

In addition to this weekly report of progress he shall report each week on a separate sheet any defective sewerage conditions as well as complaints which have come to his notice during the week.

As noted under heading of BENCH LEVELS, a report shall be made at once as to sewer manholes which cannot be found.

Insulating Wrappings for Large Water Mains

For many years it has been pointed out in ENGINEERING NEWS, in commenting on the prevention of corrosion and the mitigation of electrolysis of buried pipe and other underground structures, that complete insulation by impervious wrappings, etc., possessed great practical merits which apparently had been overlooked. It was not until Feb. 15, 1912 (p. 289) that it was possible to record a wide commercial adoption of such a scheme. The practice of the National Tube Co. was then noted in the use of impregnated felts around small pipes (3 to 18 in.).

For several months now, the East Jersey Pipe Co., of New York City, has been making use of a process, along this general scheme of protection, in which impregnated burlap is wrapped on pipe at the factory. It is obvious that greater mechanical strength of the common protective coatings against abrasion is secured during transportation and installation, if some sort of fabric is wrapped around the pipe. The effective thickness of protection is also cheaply increased.

The pipes are dipped in the regular pipe coating ("mineral rubber") as usual and, after this coat has set, they are sent to a wrapping machine in which the pipes are rotated on centers. What corresponds to the bed of a lathe in this case carries a shallow pan containing pipe coating maintained in a liquid condition by a furnace built under the pan. A carriage travels longitudinally over the pan carrying burlap strips 18 in. wide and wound on a reel. This is unwound from the reel, and wrapped on the pipe by the rotation of the latter and in traveling from the reel to the pipe the burlap is passed, by means of guide rolls, through the coating in the pan so that it becomes thoroughly soaked. The combination of the rotating motion of the pipe and the longitudinal travel of the carriage results in giving the pipe a spiral-wound burlap covering with a lap of about an inch and strongly adhesive to the pipe. The company mentioned has issued the following specifications for engineers who desire such a wrapping.

SPECIFICATIONS FOR BURLAP WRAPPING STEEL PIPE—After the pipe has been dipped in the mineral-rubber coating and the coating has sufficiently set to prevent flow in the subsequent operations, it shall be wrapped with 10-oz. Calcutta burlap, or equal, which shall be cut into strips 18 in. wide and applied in the following manner:

Pipe shall be placed on centers of a wrapping machine where it shall be slowly rotated. The burlap, which shall be carried on the reel of a carriage traveling longitudinally during rotation of pipe, shall be drawn from the reel by the revolving pipe through a tank containing a hot solution of mineral-rubber pipe coating, and shall then be wound spirally on the pipe, the burlap being lapped upon itself to about the width of an inch, the tension of the burlap while winding being sufficient to cause the burlap to lap close and snug on the pipe, but not enough to strain or tear it. The wrapping shall be kept back far enough from the ends of the pipe to leave the rivet holes accessible and not interfere with the making of the field joints. After the pipe is laid, riveted, calked, and tested the field joints are to be wrapped with one wind of the burlap which has been immersed in field coating.

A 54-IN. LOCK-BAR STEEL PIPE WITH SATURATED BURLAP WRAPPING

Pipe wrapped in this manner has been furnished during the last ten months as follows:

40,000 ft., 36-in. pipe for City of Winnipeg.
16,000 ft., 54-in. pipe for City of Minneapolis.
23,000 ft., 48 in. pipe for city of Minneapolis.
2,200 ft., 36-in. pipe for Dill & Collins, Philadelphia.
376 ft., 36-in. pipe for Montreal Water Works.

The cost of this wrapping is not excessive (from 35 to 60c. per ft. of pipe) and in the opinion of engineers who have seen it and used it, is a good investment. It is expected to add from ten to twenty years to the life of the pipe.

Condition of Experimental Telegraph Poles, Treated and Untreated, after Eight Years' Service

By C. H. Teesdale*

Plan of the Experiment—In the summer of 1905 a number of treated and untreated poles were set in the Augusta-Savannah and Helena-Meldrin† lines of the Southern Bell Telephone & Telegraph Co., near Savannah, Ga. The experiment dealt with 816 poles, one-half

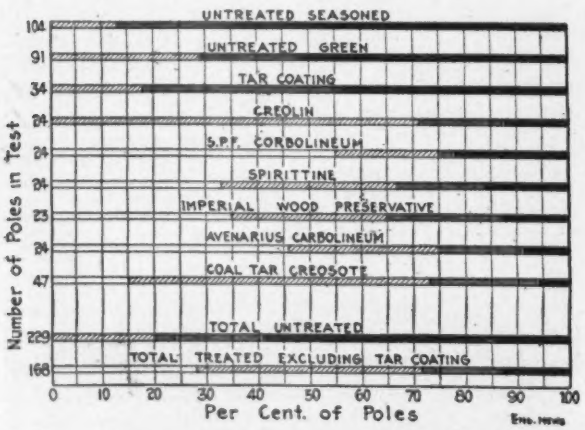


Fig. 1. Condition of Southern White Cedar Poles at Second Inspection

southern white cedar and the other half chestnut, the treated poles being alternated with the untreated ones and the series arranged as shown in Table I. The series is repeated twelve times for each species, series No. 2 beginning with pole No. 35, series No. 3 with pole No.

TABLE I. SETTING PLAN OF POLES IN EXPERIMENTAL LINE ESTABLISHED IN COOPERATION WITH THE SOUTHERN BELL TELEPHONE & TELEGRAPH CO. NEAR SAVANNAH, GA.

Pole No.	Preservative* sold as	Condition	Pole No.	Preservative* sold as	Condition
1	Avenarius carbolineum	Seasoned	18	No treatment	Seasoned
2	No treatment	Seasoned	19	Creosote	Seasoned
3	Avenarius carbolineum	Seasoned	20	No treatment	Green
4	No treatment	Green	21	Imperial wood preservative	Seasoned
5	S. P. F. Carbolineum	Seasoned	22	No treatment	Seasoned
6	No treatment	Seasoned	23	Imperial wood preservative	Seasoned
7	S. P. F. Carbolineum	Seasoned	24	No treatment	Seasoned
8	No treatment	Green	25	Creolin	Seasoned
9	Spirittine	Seasoned	26	No treatment	Seasoned
10	No treatment	Seasoned	27	Creolin	Seasoned
11	Spirittine	Seasoned	28	No treatment	Green
12	No treatment	Green	29	Tar	Seasoned
13	Creosote	Seasoned	30	No treatment	Seasoned
14	No treatment	Seasoned	31	Tar	Seasoned
15	Creosote	Seasoned	32	No treatment	Green
16	No treatment	Green	33	Tar	Green
17	Creosote	Seasoned	34	No treatment	Seasoned

* See text for analysis of preservatives.

Note.—The preservative was heated and applied to the poles with a brush; the poles were treated for a distance of 6 ft., beginning 2 ft. from the butt.

TABLE II. AMOUNT OF PRESERVATIVE APPLIED IN THE BRUSH TREATMENT OF SOUTHERN WHITE CEDAR

Preservative sold as	Number of coats	Amount applied per pole Av. lb.	Max. lb.	Min. lb.
Avenarius carbolineum	2	3.6	4.7	2.6
S. P. F. Carbolineum	2	3.7	5.3	2.8
S. P. F. Carbolineum	1	1.6	1.6	1.6
Spirittine	3	4.7	5.5	4.1
Creosote	2	4.9	6.4	3.3
Creosote	3	7.1	8.0	5.6
Imperial wood preservative	2	4.4	5.3	3.4
Creolin	2	6.0	7.4	4.5
Tar	1	7.0	...	...

*Engineer in Forest Products, Forest Products Laboratory, Madison, Wis.

†In Forest Service Circular 104 the line is referred to as the "Savannah-Abbeville-Eastman" line.

TABLE III. AMOUNT OF PRESERVATIVE APPLIED IN THE BRUSH TREATMENT OF CHESTNUT POLES

Preservative sold as	Number of coats	Amount applied per pole Av. lb.	Max. lb.	Min. lb.
Avenarius carbolineum	2	4.1	5.1	2.9
Avenarius carbolineum	1	3.7	4.6	2.1
S. P. F. Carbolineum	2	4.2	5.5	3.1
S. P. F. Carbolineum	1	3.2	3.9	2.5
Spirittine	3	6.7	9.0	4.9
Creosote	2	7.0	10.6	4.3
Creosote	3	6.5	8.3	3.8
Creosote	1	5.1	5.5	4.6
Imperial wood preservative	2	5.4	7.0	3.8
Creolin	2	6.4	8.4	4.5
Tar	1	7.0	...	...

69, etc. The average amount of preservative absorbed by each class of poles is shown in Tables II and III.

Inspection of 1909—The first inspection of the line was made in April and May, 1909,* by representatives of the American Telegraph & Telephone Co. and of the Forest Service. A careful examination was made of each pole and its condition noted.

Inspection of 1912—Another inspection of the experimental poles was made in February and March, 1912.† Owing to the advanced stage of decay found at this inspection it was necessary to change somewhat the manner of presenting the results.

In Figs. 1 and 2 the relative efficiencies of the various treatments are compared by classifications of the poles into four main groups, consisting of sound, slightly decayed and badly decayed poles, and those decayed to such an extent that removal was necessary.

The amount of deterioration is also shown by the decrease in the circumference of the poles. The circum-

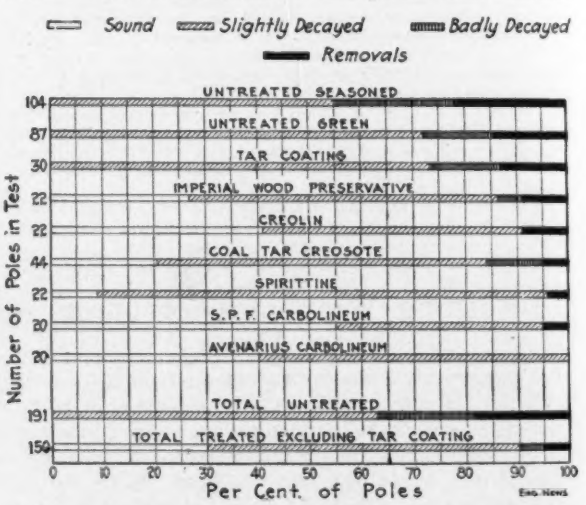


Fig. 2. Condition of Chestnut Poles at Second Inspection

ference at the point of greatest decay (usually near the ground line) was measured, first scraping away the disintegrated wood, and was subtracted from the original

*The report of the first inspection was published originally in Forest Service Bulletin 84, "Preservative Treatment of Poles," by Wm. H. Kempfer.

†The inspection party consisted of John Kirksis, representing the Southern Bell Telephone & Telegraph Co., E. B. Griffen, representing the American Telephone & Telegraph Co., and C. H. Teesdale, representing the Forest Service. Summary tables showing the condition of the poles were prepared separately by the American Telephone & Telegraph Co. Although all members of the inspection party had been in practical agreement in regard to the condition of the poles slight discrepancies appeared when the two sets of summaries were compared. The differences were not sufficient to affect the general results shown by the inspection and it was therefore considered unnecessary to attempt to bring the two sets of figures into closer agreement.

circumference* at or near the same point. However, in many cases decay occurred in the interior of the poles and left either a sound outer shell, or formed "pockets." In the latter case the width and depth of the pocket was ascertained and the circumference measurement was corrected to allow for the reduction in strength due to this decay, according to the formula of the American Telegraph & Telephone Co.

When the outer shell was intact it was sometimes deemed inadvisable to penetrate it to determine the extent of the decay; in such cases the necessary correction to the circumference measurement could be only roughly approximated by the appearance and "sound" of the poles. These conditions affected approximately 50% of the untreated cedar poles (not including the removals) but were much less prevalent in the treated cedar and in the chestnut poles. Poles entered as removals are not included in the calculations of loss of circumference.

Discussion of Results

Southern White Cedar—Most of the untreated cedar poles were found to be in a state of advanced decay, as is shown by the fact that nearly 60% were classed among the removals.† The sapwood was entirely decayed in every case and all but 20% were badly decayed in the heartwood.

The treated poles were in a much better condition; excepting those coated with tar, which proved of no value as a preservative, 28% were still perfectly sound, and only 29% were badly decayed or removed. The failure of the treated poles was probably due in many cases to the exposing of untreated wood in the interior of the poles after the treatment had been applied, due either to checking or to some other cause. Had the penetration been considerably deeper than that obtainable by a brush treatment much longer life would certainly have been secured.

As in the first inspection, white ants, or termites, were very commonly found in the poles; their destruction was confined largely to the untreated poles and to wood which the preservative had not reached beneath the protecting bands of the treated poles. These insects excavate galleries in the wood and it appeared that to some extent they hastened decay, although it may be that they followed, rather than preceded, the decay.

As the borings of the termites were in nearly all cases accompanied by decay, it was usually impossible to determine which agency was primarily responsible for the destruction; and in the tables no distinction was made between these two causes of deterioration.*

Chesnut Poles—The chesnut poles were found to be in a much better condition than the cedar. Some 63% of the untreated poles were still only slightly decayed, while of the treated poles (excluding tar coating) 91% were either sound or only slightly decayed. The average life of untreated chestnut poles cannot be estimated because of the small number of removals made to the time of the most recent inspection.

Summary

The following conclusions may be drawn as a result of this experiment:

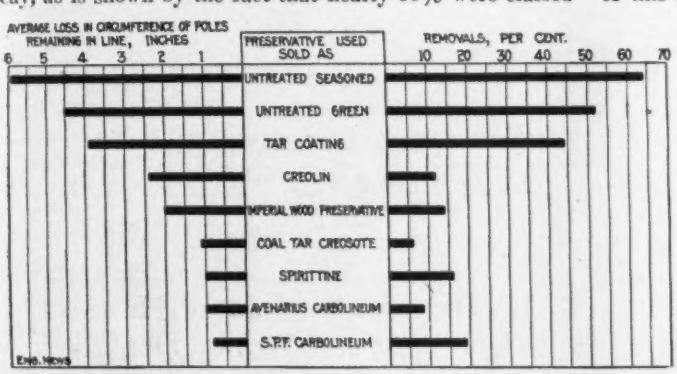


Fig. 3. Per Cent. of Removals and Average Loss of Circumference of Poles Remaining in Line at Second Inspection—Southern White Cedar

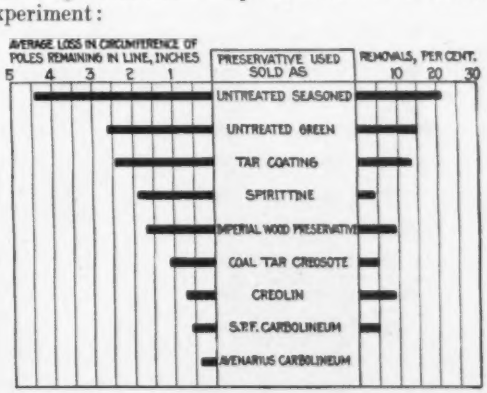


Fig. 4. Per Cent. of Removals and Average Loss of Circumference of Poles Remaining in Line at Second Inspection—Chestnut

(1) From the results of the first and second inspections it is apparent that the average life of the untreated seasoned and green southern white cedar poles in this line will not exceed 7 to 8 years.

(2) Seasoned poles set untreated show a larger per cent. of removals and a larger per cent. of poles seriously decayed, than the green ones. This is probably due to the length of time the seasoned poles were held before they were set.

(3) Poles coated with tar are in approximately the same condition as untreated seasoned poles. Although the per cent. of removals is less, the per cent. seriously decayed is greater.

(4) Good results were obtained with all preservatives except tar. In general, better results were obtained with coal-tar products than with wood-tar products.

(5) The results obtained with the carbolineums were only slightly better than with coal-tar creosote.

(6) The southern white cedar poles brush treated

*Measurements made at the time of the first inspection were used; in cases where a part of the wood had already disintegrated at that time, due allowances were made. No measurements were available for some of the chestnut poles, and in such cases the decrease was estimated from the depth of decay.

†The seasoned poles were in somewhat worse condition than those set green. The former had been held for from one to two years before they were set, and it is probable that the conditions were such that decay-producing fungi were able to get a start during this period.

*It is stated by the Bureau of Entomology that white ants, while usually confining their work to the outer layers of wood where there is incipient decay, will often completely honeycomb the sound wood of poles. See Bulletin 94, Part I, "Damage to Chestnut Telephone and Telegraph Poles by Wood Boring Insects," by Thos. E. Snyder (see "Eng. News," May 4, 1911, p. 542.)

with good preservatives showed less decay than untreated chestnut poles, but were decayed more than the treated chestnut poles.

(7) Fewer removals and fewer badly decayed poles were found in the portions of the line running through swamps and wet locations than in drier situations. The worst conditions were found in cultivated fields and dry sandy situations.

(8) Brush treatments with a good preservative give an increased life to poles sufficient to pay well for the cost of treatment. It is quite evident, however, that the amount of preservative absorbed by the wood is not sufficient to insure any great degree of permanency to the protection. Decay in treated poles was usually found to have penetrated the thin protective coating at one or two points and to extend for considerable distances underneath the sound outer portion. To be really effective the application should be sufficient to treat all the sapwood and in the case of chestnut probably some of the heartwood.

APPENDIX

TABLE IV. PRESERVATIVE SOLD AS AVENARIUS CARBOLINEUM*

	Series I	Series II
Color	Red-brown	Red-brown
Specific gravity at 17° C.	1.121	1.122
Mineral matter	0.160	0.050
Flashing point	137° C.	137° C.
Burning point	164° C.	168° C.
Distillates:		
Below 235° C.	0.41%	0.61%
Loss	0.19%	0.22%
From 235° C. to 315° C.	19.16%	26.97%
Residue above 315° C.	70.24%	72.20%
Solids, 1.7° C. to 4.4° C.	No separation	No separation
Tar acids	1.12%	1.16%

*Manufacturers' analysis: Color, red-brown; specific gravity at 21° C., 1.126; viscosity at 21° C., 115.800; mineral matter (ash), 0.047%; flashing point, 127° C.; burning point, 179° C. distillates—from 220° C. to 260° C., 4.5%; from 260° C. to 274° C., 1%; from 274° C. to 302° C., 20%; naphthalene, very slight trace; mineral acids (HCl, H_2SO_4), very slight trace; phenols, very slight trace.

TABLE V. PRESERVATIVE SOLD AS S. P. F. CARBOLINEUM

	Series I	Series II
Color	Red-brown	Red-brown
Specific gravity at 17° C.	1.134	1.134
Flashing point	135° C.	135° C.
Burning point	163° C.	162° C.
Distillates:		
Below 235° C.	0.35%	0.31%
Loss	0.13%	0.19%
From 235° C. to 315° C.	28.84%	30.10%
Residue over 315° C.	70.68%	69.40%
Solids, 1.7° C. to 4.4° C.	No separation	No separation
Tar acids	1.30%	1.30%
Mineral matter	0.31%	0.47%

TABLE VI. PRESERVATIVE SOLD AS SPIRITTINE*

	Series I	Series II
Color	Green-black	Green-black
Specific gravity at 17° C.	1.032	1.031
Flashing point	90° C.	90° C.
Burning point	99° C.	101° C.
Distillates:		
Below 235° C.	15.14%	14.97%
Loss	0.65%	0.53%
From 235° C. to 315° C.	26.23%	25.60%
Residue above 315° C.	57.98%	58.90%
Solids, 1.7° C. to 4.4° C.	No separation	No separation
Tar acids	15.40%	16.30%
Mineral matter	0.14%	0.02%

* Manufacturers' analysis: Color, green-black; specific gravity, 1.03; flashing point, 78° C.; burning point, 93° C.; distillates—below 315° C., 37.40% above 315° C. 52.60%; coke and gas corresponding to, 9.91%.

TABLE VII. COAL-TAR CREOSOTE

	Series I	Series II
Color	Greenish-brown	Greenish-brown
Specific gravity at 38° C.	1.035	1.035
Distillates:		
Below 170° C.	0.17%	0.09%
From 170° C. to 205° C.	1.25%	0.70%
From 205° C. to 210° C.	1.14%	0.74%
From 210° C. to 235° C.	43.96%	45.92%
From 235° C. to 240° C.	6.66%	6.12%
From 240° C. to 270° C.	19.48%	20.03%
From 270° C. to 300° C.	10.07%	9.61%
Residue above 300° C.	17.00%	16.30%
Loss	0.27%	0.49%
Total	100.00%	100.00%
Naphthalene	45.10%	46.1
Liquid at	38° C.	38°
Tar acids	9 c.c.	8.2

TABLE VIII. PRESERVATIVE SOLD AS IMPERIAL WOOD PRESERVATIVE

	Series I	Series II
Color	Greenish-black	Greenish-black
Specific gravity at 17° C.	1.035	1.03
Flashing point	115° C.	111
Burning point	129° C.	123
Distillates:		
Below 235° C.	2.51%	3.6%
Loss	0.29%	0.5%
From 235° C. to 315° C.	26.00%	24.7%
Residue at 315° C.	71.20%	71.10%
Solids, 1.7° C. to 4.4°C.	No separation	No separation
Tar acids	13.70%	11.80%
Mineral matter	0.04%	

TABLE IX. PRESERVATIVE SOLD AS CREOLIN

	Series I	Series II
Color	Light-brown	Light-brown
Specific gravity at 38° C.	1.007	1.005
Distillates:		
Below 170° C.	26.66%	96.90%
From 170° C. to 205° C.	17.39%	0.10%
From 205° C. to 210° C.	9.27%	
From 210° C. to 235° C.	25.02%	
From 235° C. to 240° C.		
From 240° C. to 270° C.	15.98%	0.15%
From 270° C. to 300° C.		
Above 300° C.	4.24%	0.85%
Loss	0.54%	2.00%
Total	100.00%	100.00%
Naphthalene	35.19%	None
Water	20.00%	90%
Tar acids	19 c.c.	1 c.c.
Note	Sticks and other foreign matter present.	Sticks, sand, and other foreign matter present.

Analysis of Preservatives—Samples of the preservatives used for the treatment of experimental poles in the Augusta-Savannah and Helena-Meldrin lines were analyzed by the engineering department of the American Telephone & Telegraph Co. These analyses were made in accordance with the company's methods for the analysis of creosote and carbolineum standard at the time these treatments were made (1905). The results of the analyses are shown in Tables IV-IX.

The Organization of the Hartford, Conn., Water-Works Department*

Hartford, the capital city of Connecticut, has a population supplied with water estimated to be 126,590 at the present time. The city has a gravity supply derived from streams and impounding reservoirs, the original establishment of which dates from 1854. The average daily consumption of water is 8,640,000 gal., or 68.2 gal. per capita. There are 13,278 service taps, 98.7% of which are metered.

In the latter part of the year 1911 the city began work on an extensive project for an additional water-supply; and on Jan. 1, 1912, the construction and maintenance work of the water department was placed in charge of Caleb Mills Saville, former Division Engineer of the Metropolitan Water-Works of Boston, Mass., and more recently in charge of the Third Division of the office of the Chief Engineer of the Panama Canal.

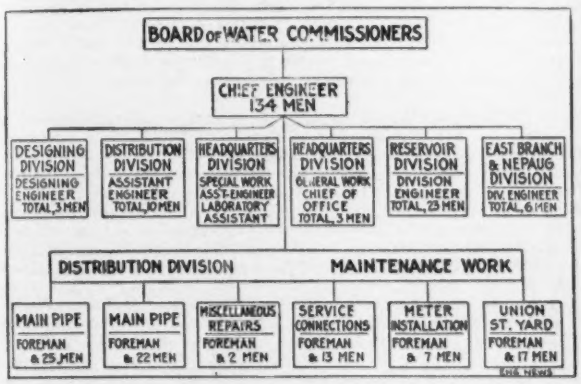
Under Mr. Saville's direction a new organization of the engineering staff was effected, the scheme adopted being that shown by the accompanying chart. The work of the department includes, besides the routine maintenance and additions to the present water-works and city service equipment, the preparation of plans and the supervision of construction of two new large reservoirs, 10 to 20 miles, northwest of the city, and their incidental dams and conduit systems.

*Based on Annual Report of Board of Water Commissioner for year ending Mar. 1, 1913.

A glance at the chart shows that all division and subdivision heads report directly to the Chief Engineer, who is thus in direct touch with every phase of the work. There are in reality but five main divisions, the administrative, designing, distribution divisions and the two divisions in charge of the reservoir projects. Under the administrative division may be grouped the two headquarters divisions, for special work and for general work, and the distribution system maintenance work, which is under the direct supervision of the various foremen.

The Designing Division under the Designing Engineer has charge of the preparation of the detail plans and specifications for all new work both of the reservoir and distribution systems. The work of this office includes, besides plans for construction work, a great deal of drafting work on general maps, work tables, diagrams, etc., for studying various projects.

The Distribution Division under an Assistant Engineer makes surveys of all streets in which new pipes have been laid, to make permanent records of the locations of all



ORGANIZATION CHART OF THE HARTFORD, CONN., WATER-WORKS DEPARTMENT

main pipes, service pipes, gates and hydrants. This division also investigates leaks in the distribution system by gate-valve tests, pitometer surveys and general inspection work. Check valves in use on all fire mains supplying factories having auxiliary supplies from other than city mains are tested regularly each month. This division has supervision of the work of cleaning water mains, which is done under contract; besides, of course, the usual routine engineering work in connection with maintenance. The actual work of laying and repairing water mains, making service connections, installing meters, etc., is under independent foremen, who are responsible only to the Chief Engineer.

The Headquarters Division consists of two independent units, the first in charge of an Assistant Engineer engaged in special hydrographic work in connection with stream-discharge measurements, and second in charge of an office chief who looks after the general administrative and clerical work relating to construction. The Laboratory Assistant, or Chemist, reports directly to the Chief Engineer. His work, besides the usual routine of water analysis, has included percolation tests of soils at a proposed new dam site, tests of the corrosion of iron and steel plates to compare the relative merits of ingot iron and steel for pipe lines, and tests to determine the feasibility of using Connecticut River water dosed with hypochlorite of lime in case of emergency.

The Reservoir Division, in charge of a Division Engineer, has the supervision of the existing water-supply reservoirs. This division keeps rainfall records and storage records for each watershed and reservoir, a daily record of total water consumption, makes investigations of the leakage through and under dams, and looks after the usual maintenance work on reservoir grounds and equipment. This division also has charge of surveys and construction of the part of new tunnel and conduit which comes within the old reservoir watershed.

The East Branch and Nepaug Division is the engineering staff in charge of the surveys and construction of the two new reservoirs, dams and incidental structures. Besides surveys and supervision of construction this division also prepares the general plans, maps and profiles for use of the Designing Division.

Motor-Bus Operation

[Report to the Mayor of New York, by John A. McCollum, Assistant Engineer, continued from "Engineering News," Nov. 20, 1913, p. 1052.]

COST OF OPERATION

LONDON—The operating companies are very loath to divulge accurate details as to the cost of operation, for use in a public report. From information obtained, however, it would seem that the average cost of operation of the London General Company may be stated to be roughly as follows:

	Per Vehicle Mile
Operating cost	15 cents
Interest, depreciation, etc	02 cents
Total	17 cents

The National Steam Car Co. claims that the cost is a little less than that of the London General Omnibus Co. By the use of kerosene for fuel, it avoids payment of the fuel tax of 3c. per gallon on gasoline, which is equal to about 0.4c. per vehicle mile.

Thomas Tillings, Ltd., submits the following figures as to the cost of running its type of cars 1,387,031 miles in 1912:

Running and maintenance	2.326 c.
Tires	2.210 c.
Drivers	2.514 c.
Gasoline, lubricating oil, grease and paraffin	2.394 c.
Vehicle lighting	0.150 c.
Rents, rates, taxes, garage, lighting, water, trade vehicles, depreciation	1.972 c.
Conductors	1.694 c.
Body upkeep	0.470 c.
Trafic expenses	0.534 c.
Total cost per mile	14.264 c.

The costs as given for the operation of the cars used by the General Omnibus Company and the National Steam Car Company are very approximate, and were not given in detail.

The figures as furnished by Thomas Tillings, Ltd., are used by the Tillings-Stevens Company, the manufacturers of the omnibuses used by Tillings, and may include the cost of workings of cars other than those actually used in the streets of London, and are given to show the economical features of the Tillings-Stevens bus.

PARIS—The following table of cost is given by the Company as approximate, and it is believed by the company that certain of the items are susceptible of reduction in the future. The figures given by the company were in decimals of francs per kilometer, but this has been reduced to cents and decimals thereof, per mile, in order to compare with the data given for the operation in London:

Maintenance of chassis	4.022 c.
Maintenance of bodies	0.928 c.
Maintenance of tires	3.714 c.
Brushing and cleaning and lighting and heating of vehicles	0.821 c.
Fuel, including the City toll thereon	6.574 c.
Oil, grease and waste	0.650 c.
Machinist	3.094 c.
Expenses at the depots (supervision, lighting, motive power, tolls, shippers, etc.)	1.857 c.
Average cost per mile	21.660 c.

This does not include reserve funds for renewals, nor expenses of actual operation (conductors, drivers, inspectors, etc.), nor general expenses (administration, insurance, accidents, taxes, franchise payments, maintenance of buildings, etc.)

NEW YORK—The annual report of the Fifth Avenue Coach Co., submitted to the Public Service Commission for the First District, covering the operations of that company during the year ending June 30, 1912, states that there were in operation 81 vehicles during the year, which were operated a distance of 1,440,841 miles. Using this mileage and the items of operating expense given therein as a basis, the average cost of operation per mile was computed with results as follows:

Maintenance, buildings and fixtures	00.035 c.
Tires	03.132 c.
Maintenance, equipment	07.208 c.
Conducting transportation	17.565 c.
Damages and injuries	03.042 c.
General expenses	02.308 c.
Total operating expenses per mile	33.290 c.
Depreciation of vehicle equipment, figured at the monthly rate of 1-36 of total cost	05.311 c.
Taxes	02.697 c.
Total operating cost per mile, including depreciation and taxes	41.298 c.

The cost figures as given above for London and Paris are only approximate and practically of no use in estimating the cost of operation in New York and other American cities. The cost of labor, particularly skilled mechanical labor, is a great deal less in those cities than in New York and some advantages may also be obtained in the original cost of a well constructed vehicle as well as in the upkeep. Different types of vehicles are operated in each city, and this, no doubt, has also a large bearing on the operating cost per mile. The vehicle used in Paris is much heavier than the London type, though the capacity is about the same or less, while in New York there are various types of vehicles including some which have a much larger capacity than those of either London or Paris and of a greater weight. This probably would not, however, account wholly for the greater difference in cost of operation over that of London and Paris.

SUPERVISION OF MOTOR OMNIBUSES IN OPERATION, LONDON

The rules applying to motor licensing and operation of motor-stage carriages now in use were issued in August, 1909. The rules permit only the operation of omnibuses weighing 2 tons 10 cwt. or less, unladen, or weighing not exceeding 6 tons laden; the distribution of laden weight being 4 tons on rear and 2 tons on front axle. In computing laden weight, 140 pounds is allowed for each passenger and member of crew; the number of passengers being in any event limited to 34, 16 inside and 18 outside. This was a decided reduction in weight of vehicle over that formerly used. The manufacturers and proprietors of omnibuses at first felt that it would be impossible to design a vehicle of this weight which would give efficient, economical and satisfactory service. However, this has been done, and all are now satisfied that the present type of vehicle is much better than any which had heretofore been attempted.

A new type of motor vehicle intended for licensing must be submitted to Police Headquarters for inspection, together with a proprietor's certificate of registration and a manufacturer's certificate stating that the vehicle is in every way fit for use as a public carriage. If a vehicle is approved by the Police Department it then goes to the Noise Committee, which committee consists of three men appointed by the Commissioner of Police, but outside of the Department of Inspection. This Committee then submits the vehicle to three general tests:

(a) Operation of vehicle loaded to full extent.

(b) Operation on a gradient of 1 to 16 or 17 for a distance of about 600 yards.

(c) Operation on level.

Each member of the Committee marks the rating of each noise test separately, and the average of the three ratings is taken as final, and, if passed, the license is issued and the vehicle is permitted to operate upon the streets.

During the year 1912, 2908 motor omnibuses were licensed. The number of reports of defects of motor omnibuses made by the police during the same period was 13,117, 7677, or more than one-half of the reports, were made because vehicles produced an undue amount of noise. This rigid inspection by the police has certainly had its effect. The noise caused by the motor traffic in the most congested places in London is not such as to attract particular notice, though the density of traffic at such places is astonishing.

The provision of the Motor Car Act relating to the speed or motor power is as follows:

"If any person drives a motor car on a public highway recklessly or negligently, or at a speed or in a manner which is dangerous to the public, having regard to all the circumstances of the case, including the nature, condition and use of the highway, and to the amount of traffic which actually is at the time, or which might reasonably be expected to be on the highway, that person shall be guilty of an offense of this act."

Under this provision, the policeman is made the judge (in so far as the issuance of summonses is concerned) of whether there is excessive speed or reckless, negligent or dangerous driving, and the policeman is generally upheld by the courts.

SPEED OF THE MOTOR BUS

LONDON—The Police Regulations require omnibuses to be so geared that the highest speed shall not be in excess of the maximum laid down by the Local Governing Board—namely, 12 miles per hour—or to be fitted with an approved device which shall give a constant warning as often and as long as the speed of twelve miles per hour is exceeded. This provision is not enforced by the police. The motor-car act prohibits a speed in excess of 20 miles an hour, the Local Governing Board having the right to further limit the speed in certain districts.

Omnibuses of the General Company are started from the garages on a fixed schedule and are allowed a fixed time to cover the route. Inspections are made at various points to determine whether or not the driver has exceeded the speed necessary to reach the point where the inspection is made. The time permitted for covering a route is arrived at after elaborate experiments, in which both representatives of the company and the drivers take part. Complete logs of the journey are taken throughout different hours of the day and averaged by a timing committee, which decides how much time should be allotted during different periods of the day to travel the route.

The average speed between 9 a.m. and 7:30 p.m., including stops, for seventy-seven routes, as computed from the average speed of each route furnished by the company, is about 8.1 miles per hour, while the maximum for a route is 10.8 miles per hour, and the minimum is 7.4 miles per hour.

It is stated that the point-to-point speed of the motor bus increased considerably with the development or improvement of the vehicle, without increase of the maximum speed. This has been brought about by the more frequent service diminishing the number of stops per vehicle and by the more rapid acceleration of the newer types. The motor bus as compared with the double-deck surface cars has a distinct advantage in that its capacity is less; therefore the stops are less frequent. The capacity of the motor bus is one-half that of the London double-deck surface car; consequently, two motor busses are required to do the work of one car and the number of stops per bus may not exceed one-half that of the surface car.

Tests were made on September 2 and 3, 1913, to determine whether the speed of the motor bus, as compared with that of the street surface cars in New York, bore the same ratio as in London. It was found, judging from the few tests made, that the motor-bus speed from point to point, including stops, somewhat exceeded that of the surface car, but this difference was probably to a degree caused by the larger number of stops made by the surface car because of its larger capacity.

PARIS—The speed of the motor bus is considerably greater than in London. One reason, no doubt, for this is that there is scarcely any congestion of street traffic in Paris, while in London the congestion is great. The vehicle used in Paris is geared for a somewhat greater speed than that in London, and this, together with the heavier vehicle, produces a great deal of street vibration as well as an impression that the vehicle is traveling faster than the actual speed. The omnibus travels considerably faster than the Paris street cars, the difference being considerably greater than in London.

LIFE OF VEHICLE, COST, DEPRECIATION, ETC.

LONDON—It is difficult to state what the length of life of motor bus is. The system of inspection and repair of the vehicles in use by the London Omnibus Company is most complete. Under normal use a vehicle is off duty 10% the time. Wearing parts are interchangeable and are easily replaced. A general overhaul occurs once each year, just before the vehicle is submitted to the Police for a renewal of license. Under this system, but few of the parts are left which belonged to the original vehicle except the frame and axles, after a few years' operation, and it can at no time be said that the vehicle is unfit for service because it is worn out. It has been estimated that the normal life under these conditions might be ten to twelve years, or probably longer, but experience up to this time has shown that a vehicle becomes obsolete after five or seven years' use because of improvements in design which make the new vehicles more efficient and economical in operation. But very few of the

vehicles which were used by the General Omnibus Co. a few years ago are now in operation.

The price of the vehicle used by this company varies from $3500 to $4000 each. However, this is the list price, and is without doubt materially decreased when a considerable number of vehicles are ordered at one time. Assuming, therefore, that when bought in quantity these vehicles cost $2500 and that the normal life is six years, a replacement fund of about $400 a year would be necessary for each vehicle. As a matter of fact, I believe this sum is not far from that set aside by the London General Company.

The National Steam Car Company sets aside one-sixth of the cost of the car each year and it is claimed by that company that it now has cars in operation which have been in service eleven years. The cost of this car, however, when new, is somewhat greater than the gasoline cars used by the General Company. The National Company also claims that 97 per cent. of its fleet is in operation throughout the year.

PARIS—What has been said about the inspection and replacement is also true with respect to the vehicles used in Paris. The type of cars now in use has been operated less than three years and is therefore of comparatively new design. The cars, however, are repaired and parts replaced in such a manner that the vehicle is practically in a perfect state of repair all the time. The cost of the Paris bus is considerably greater than that used in London. It is said to be more than $4000, and an ample depreciation fund is provided to take care of replacement.

FINANCIAL CONDITIONS OF OMNIBUS COMPANIES

The General Omnibus Company, having attained a practical monopoly, has increased its service both by schedule and territory and must necessarily maintain a complete, efficient service in the entire territory to prevent competition. It is without doubt operating many lines which in themselves show a small profit.

The percentage of gross receipts required for operation, compared with street railways, seems very high, being more than 90 per cent. During the last six months of 1912, the cost of operation was 92.3% of the gross receipts. This, of course, includes maintenance and depreciation. The capital invested, however, is very much less than the corresponding investment in street surface railways by the London County Council, the proportion being, in comparison with the number of passengers carried in 1912, as follows:

	Passengers Carried	Capital Invested
London County Council Tramways ..	512,652,652	$53,000,000
London General Omnibus Co.	492,858,934	15,500,000

From this it is easily seen that the capital required in the omnibus business per passenger carried is far less than similar capital for street surface railways as operated in London. With, therefore, this small capital investment, the operations of the London General Omnibus Co. are considered to be very profitable, even though the operating expense, as compared with the gross receipts, seems to be abnormally high.

ACCIDENTS

The increase in the number of accidents caused by omnibuses and motor vehicles in London streets resulted in the appointment of a parliamentary committee in November, 1912, to inquire into the circumstances which led to the increasing number of fatal accidents due to omnibuses and other forms of motor-driven vehicles and to make recommendations as to measures to be taken to secure greater safety. This committee was re-appointed in March of this year, volumes of testimony were taken, and on August 11th the committee made its report.

The report of the Committee gives the following statistics with respect to fatal accidents caused by motor omnibuses in both the Metropolitan police area and in the ancient city of London:

Year	Licensed	Fatalities	Per 1000 Busses
1909	1189	59	50.0
1910	1200	70	58.3
1911	1962	114	58.1
1912	2908	182	62.6

The same report states that the Metropolitan police give as the result of motor-bus operation for the first six months of 1913, 87 deaths and 1582 accidents, and that on the assumption of the number of omnibuses being 3000, public carriages 11,000 and estimated private power vehicles 14,000, "a very serious disproportion of fatalities caused by motor omnibuses is shown."

Recommendations of the Committee in part are:

1. That all mechanical stage carriages and hackney carriages be brought under closer control.
2. That the routes, time tables and number of stage carriages be subject to municipal regulation.
3. That the design of mechanical stage carriages be subject to a new traffic branch of the Board of Trade (which it recommends be established), with independent expert advice.
4. That the licensing of stage carriages be a duty of the local authorities subject to right of appeal to the New Tariff Branch of the Board of Trade instead of a duty of the Police as at present.
5. That special speed limits for motor omnibuses and other heavy motor traffic be imposed for conditions especially dangerous.
6. That closer control of traffic be exercised by the police.
7. That traffic points be fixed at a greater number of crossings.
8. That more refuges in the streets be provided.

The omnibus companies deplore the many accidents which have occurred, and the rapid increase in their number and have devoted considerable energy to obtain means for their prevention. Rewards have been offered by the General Company for safety devices. Many suggestions have been received by that company and fenders have been designed for the rear wheels, which are being supplied to the vehicles as fast as can conveniently be done. This fender is so simple it seems strange that its use was not long ago demanded. It has already been the means of saving several lives, it is said. No practical device has yet been designed for defending pedestrians from the forward wheels, but it is believed that such a device will eventually be found. The number killed by the forward wheels about equals the number killed by the rear wheels, which means that safety devices for the rear wheels only should materially reduce the number of fatal accidents.

The development and the increase in number of the motor busses have been so rapid that it is not astonishing that many accidents are caused by their operation. The motor bus used in London is considerably heavier and larger than the average motor vehicle in use, though the number of heavy mechanically propelled commercial vehicles in operation in London is very great. The increase in the number of motor busses has, of course, made it difficult to develop efficient drivers who have the quickness and instinct to avoid accidents. It is stated that drivers of horse omnibuses have made the best drivers of motor omnibuses, when they have been of such age and strength as to be available for that purpose. The efficiency of that class of drivers is said to be due to the long training in driving horse vehicles in the streets and the instinctive ability to avoid accidents gained thereby. With such rapid increase in numbers, a large proportion of the drivers are what may be termed "green," not having had the experience in street work to give them the highest mark of efficiency. An elaborate training school is maintained by the company and each man is submitted to several weeks' training at the expense of the company before he is permitted to operate on the streets independently of supervision.

There are many features of the design, operation, regulation and control of the motor bus which have a direct bearing on the number of accidents resulting therefrom, but even with the best design and most efficient control accidents will, without doubt, occur in large numbers as a result of a large fleet of busses.

PARIS—No definite statistics with regard to accidents could be obtained in Paris, aside from the fact that accidents were rapidly increasing in number. Practically no congestion of traffic exists in Paris, and the absence of heavy motor vehicles (aside from omnibuses) is striking. Street supervision is by no means as thorough as it is in London. The number of motor cabs is increasing rapidly and it is believed that if definite statistics could be obtained, a large number of accidents would be shown to have occurred both from motor omnibuses and cabs.

GENERAL DISCUSSION, COMPARISONS, FRANCHISE TERMS

Judging from the systems in operation in London and Paris, it is my opinion that disregarding the cost of operation, the omnibus has certain advantages over the surface car in performing the same work, which cannot be lightly considered:

1. The motor bus is independent of a large complicated system outside of the vehicle itself; it is itself a complete traffic unit.
2. It can easily adapt its movements to street traffic.
3. Not being confined to a fixed track, vehicles may run side by side, thus clearing dense traffic intersections much more rapidly than the surface electric railway cars.
4. Routes may easily be changed, either temporarily or permanently; temporarily when there is obstruction due to fire, parades, etc.; permanetly when desirable because of change of traffic conditions, making other routes more desirable to the traveling public, and without loss of investment in permanent street structures.

5. Passengers entering or leaving busses may do so at the curb without risk of crossing dangerous street traffic.

6. The breakdown of one vehicle in the street does not derange the service of other vehicles of the same system.

7. Point to point speed somewhat exceeds that of the street car without exceeding maximum speed of the street car.

On the other hand, it may be said that the motor bus has also its disadvantages, when compared with the street surface car:

1. It is a constant source of accidents. London statistics show it to be much more so than other fast-moving motor vehicles.

2. The motor bus, because of its limited capacity, is unable to provide rush-hour facilities as effectively as the street car of larger capacity. (This is on the assumption that the weight and capacity of motor vehicles are rigidly limited, as in London.)

3. The capacity of the motor bus being less than that of the street car, more moving vehicles in the street are necessary to do the same amount of work, thereby increasing the liability of accidents.

4. When operated in large numbers, the motor bus will require more rigid regulation by the municipal authorities as to type of vehicle and method of operation.

5. Less comfort to passengers, due to vibration. This vibration increases as the street surface becomes more uneven.

A study of the omnibus operation in London and Paris leads me to believe that should motor-busses be permitted, the City should exercise its authority in three general ways:

First—As to the routes.

Second—As to the type, size, weight, capacity, etc., of vehicle.

Third—As to operation.

First—As to route.

(A) The motor bus should not be permitted on any route unless it will thereby fill a place in the transportation field not already supplied, or if it is to duplicate the service already furnished, unless it will thereby provide a much more complete, efficient, economical, comfortable or otherwise better facility than that now existing.

If the motor bus is to perform the same function as the street surface railways, there seems to be no more reason why its routes should parallel street railways in the same streets for long distances than that there should be two street railways upon such routes, unless the motor bus can do the work in a manner more advantageous to the public. All must agree that two street surface railways serving the same district and operating over the same street, should not be permitted unless the facilities offered by one of the companies are so inefficient that the services of the other company are demanded for relief.

(B) Motor busses operated by more than one company should not be permitted on the same route.

To say the least, two lines of motor buses under different control, operating in the same street, would not tend to diminish the number of accidents. With such competitive operation, police regulation would be almost without effect. It is stated by the officials of the London General Company and others, that before the amalgamation of the omnibus companies in London, many accidents were caused by racing or interference, which does not take place when the omnibuses are under one management. I venture to predict that in any event should more than one company be given a franchise to operate omnibuses in New York, it will only be a short time when one company will control the entire operation.

(C) Motor busses should not be operated in the same street with street surface railways, except for short distances where such duplication of route is necessary because there are no other existing highways available for that portion of the omnibus route.

Aside from the question of competition already discussed, the operation of busses in large numbers in surface railway streets should not be permitted because of danger from accidents which might result therefrom. The operation of omnibuses in such streets would make it more difficult for pedestrians in crossing the streets and add to the congestion of traffic which must be crossed by the street-car passengers. It has been stated by some that deliberate interference by the busses in such streets has occurred in London, the omnibuses in some cases stopping immediately in front of the entrance to or exit from surface cars, making it practically impossible for passengers to board or alight from the car.

(D) Motor busses should be excluded from streets having macadam pavement and permitted only on pavement having a heavy foundation.

It would undoubtedly be a better principle to adapt motor routes to the type of pavement in the beginning, rather than to supply pavement capable of supporting motor-bus traffic after, operation has begun. The latter method is used in London because the laws are such that motor traffic cannot be excluded from routes selected by the operating company and has resulted in large expense which could otherwise have been avoided.

London authorities agree that motor-bus operation destroys macadam pavement and that the thickness of the foundation of all pavements bearing heavy motor traffic must be increased.

Motor traffic in New York is becoming heavier each year, and without doubt our pavement foundations must eventually be increased in thickness to support it. The immediate employment, however, of a large fleet of omnibuses operating in many streets would probably cause a large outlay for repaving in the near future which would otherwise be unnecessary for some time to come.

Second—As to type of vehicle.

(A) Weight of vehicle should not exceed that permitted by police regulation of London.

This weight limit has been fully explained herein and was adopted in London only after a thorough investigation and experience with heavy vehicles, and has resulted in the construction of a type of vehicle within that weight limit which gives entire satisfaction to the operating companies, is easily handled by skillful drivers in street congestion and produces little street vibration. The weight is probably one of the most important features in the design of the motor bus. Upon it depends largely the life of the pavement, comfort of the inhabitants on the route and safety of passengers and pedestrians.

(B) Power should be retained by the franchise whereby the Board may govern all features of the construction, size, power, etc., of the vehicle, with the right to change any rules when experience shows that such change will be of benefit.

This will require expert advice, but the matter is so important from the standpoint of accidents and street wear that the Board should have the widest powers in the premises. Many of the London rules in this regard may be used during the beginning of operation, but experience only will be the proper guide in the matter.

Third—As to operation.

(A) Rate of fare should depend somewhat on distance traveled.

This method is more equitable both for the traveling public and the company.

(B) No advertising signs should be permitted on the outside of omnibuses.

The reason for this is obvious.

(C) Rate of speed should be limited, not by a maximum speed limit only, but in regard to dangerous or reckless driving as well.

The present New York State Law provides that a motor vehicle shall be driven in a careful and prudent manner at a rate of speed so as not to endanger the property of another or the life or limb of any person, provided that a rate of speed in excess of 30 miles an hour for a distance of one-fourth of a mile shall be presumptive evidence of driving at a rate of speed which is not careful and prudent. This law seems to conform somewhat to the above rule, but, without strict enforcement the operation of large numbers of motor busses in the streets will result in many serious accidents.

(D) Upkeep of vehicles should be insisted upon with a penalty provided for failure to comply with rules in regard thereto, and thorough municipal inspection should be maintained.

The effect of this inspection in London has already been explained. The Parliamentary Committee, in its recent report upon accidents, recommended that omnibuses be brought under still closer control. Its importance as affecting the safety and comfort of inhabitants cannot be overestimated.

TERM OF FRANCHISE GRANT—Whatever is done at first in the operation of motor omnibuses in New York can only be at best an experiment. The term of the grant of a franchise for such experimental operation should be as short as is possible, and at the same time give the company a fair chance to close down its operations at the end of the term without financial loss. The life of any one type of vehicle probably does not exceed six years, as has already been explained. In order, therefore, that a profit may result from the operation, sufficient funds must be laid aside each year from earnings to replace the vehicle at the end of the six-year period. Since the motor-bus operation does not require any expenditure in permanent way in the streets and the largest investment is in the vehicles themselves, the short life of the vehicle has a large bearing upon the term of grant which the company can accept. It is believed that in no case should the first franchises for omnibuses be granted for a period exceeding ten years in duration, and for much shorter time if it can be shown that the company can afford to accept such shorter term.

EDITORIALS

We recently discussed in these columns the general advance in the interest rate on bond issues of all classes. That 5% is now necessary to make even a high-class municipal bond readily salable is recognized by a circular just issued by a suburban town in New Jersey, advertising an issue of $132,000 of bonds with interest at 5% payable semiannually. The town's assessed valuation is nearly $7,000,000 and its total bonded indebtedness including this issue is about $600,000. It is further noteworthy that the bonds are to run for 20 years.

The Need for Water Meters at Baltimore

Of the many unreasonable ways of charging for water, few, if any, are more unreasonable than the frontage plan. Under this system charges are based on the width of the house, regardless of the quantity used.

Baltimore is operating under this unreasonable plan and, as only 3500 of its 125,000 consumers are metered and house connections are being made with its new sewerage system, its water consumption, already high, is going up—118 gal. in 1911, 128 gal. in 1912, with prospects of a further rise for 1913. The obvious step to take to control the leakage and waste which cause this high consumption is to install meters, but the water department lacks authority to do this, even where property owners would pay the cost.

Since Baltimore is now building a filtration plant which will add to the cost of water, and since it is burdened with many millions of debt for sewerage, sewage disposal, paving, etc., it is high time that it abandon its waste-encouraging method of charging for water, and to sell it on a metered basis. This will reduce waste, and with it the cost of water and the demand for larger water mains, while at the same time substituting a fair and equitable for an unfair and inequitable plan of charging for water.

A National Good Roads Meeting

How much or how little does it mean when one reads in the newspapers that this or that or the other Association in convention assembled has adopted a resolution upon some matter of public importance? The above question is suggested by the proceedings of the United States Good Roads Association, which held a national convention last week in St. Louis. The convention had been widely advertised, and a long list of the dignitaries who were to be in attendance had been published, included in which were the governors of 28 states. When the convention assembled, however, one lone governor was all that had been corralled. The total number in attendance at the convention, all told, was not over 200, and not more than half of these were present at any session. The time of the convention was devoted to spread-eagle oratory, mainly directed toward furthering the project to tap the Federal treasury for road-building funds. The resolutions adopted favoring Federal aid appear to have been prepared in advance and were adopted according to program. There was little or no discussion of either the resolutions or the speeches.

It is evident that resolutions of this sort, adopted by such a body, in such a manner, are no more representative of intelligent public opinion that would be the resolutions adopted by any chance assemblage of men anywhere, such as a political club, a country grange, or one of the numerous commercial organizations whose members rarely assemble in any number, all work and proceedings being carried on by the secretary with perhaps a small executive committee.

An excellent illustration of the latter sort of resolution is the recent adoption by a New York City commercial organization of a resolution approving the fantastic scheme of Mr. Riker, to solve the problem of Mississippi River floods by digging a channel parallel to the river, ten miles wide and extending from Cairo to the Gulf. The probabilities are that not one in a hundred of the members of the organization referred to, ever saw the resolution or would have the necessary information to pass an intelligent opinion upon it if they had seen it.

More Revelations in "High Finance"

The investigation of the St. Louis & San Francisco R.R. Co., by the Interstate Commerce Commission, it was announced on Nov. 21, has revealed that this company, which was recently placed in a receiver's hands, is carrying an indebtedness of $40,000,000, made up of commissions paid to bankers and brokers for the sale of its securities and exorbitant profits to promoters of railway lines in the Southwest which it has purchased. Quoting from the summary of the report given out for publication, it is stated:

> That the chairman of the company's Board of Directors, B. F. Yoakum, made $7,000,000 profits for himself and associates trading with himself in the capacity of promoter and builder of Texas roads, which he caused to be sold to the Frisco at prices in excess of their value. Approximately $32,000,000 of the Frisco's total indebtedness of $24,000,000 was paid to bankers and brokers in commissions. The average rate of commission was 12.05%, while the profit of Mr. Yoakum and his associates in the promotion of the feeder lines sold to the Frisco ranged from 10% to more than 100%.

One of the principal items in the profits made by the sale of branch lines to the company was in the construction of the St. Louis, Brownsville & Mexico R.R., which netted its promoters and builders a profit of $3,000,000 when sold to the Frisco, this being about 75% on their investments. Officials of the St. Louis & San Francisco Co., according to the evidence before the Commission, were personally interested in nearly all the branch roads sold to the company. The idea that the promoters and builders of these roads were entitled to make a large profit because of the risk they incurred in undertaking the enterprise, is contradicted by the testimony that many of the roads were constructed under an agreement

with Yoakum, by which they were to be purchased by the Frisco after completion.

The effect of these revelations upon public opinion, coming at a time while the financial collapse of the New Haven Railway corporation is fresh in the public mind, can hardly be overestimated. It will have a greater influence in destroying public confidence in railway investments than all the restrictive railway regulations and court decisions of the States and the nation combined. It may even have a serious influence upon the demands of the railway labor unions for higher wages and upon the appeal for permission to advance railway rates. The railways are urging that they cannot afford to pay higher wages and that they must have higher rates to continue solvent; but the man who works for a daily wage and incurs the risk of life and limb in the railway service is suspicious that the money which is saved by keeping down his wages is not going either to holders of bonds or of stock, but to increase the fortune of some wealthy director. It is in this way that the financial crimes committed by the Wall St. pirates who are in control of certain railway lines are reflected as an injury to the credit and the standing of railways which are honestly managed. There is law enough on the statute books to send to the penitentiary any director of a corporation who uses his position of trust for his own profit at the expense of the company's stockholders; and it is time that such laws were put into force.

The Bactericidal, Deodorizing and Physiologic Properties of Ozone

Ozone, like its mother, electricity, too often has been made a name to conjure with for the profit of promoters at the detriment of users. Various claims of bactericidal and deodorizing effects of ozone—or rather of air bearing appreciable quantities of this peculiar form of oxygen—have been and still are made, the claims ranging from the conservative to the extravagant with the latter predominating perhaps. In our issue of Apr. 28, 1910, we reprinted a few well authenticated results of disinfection tests which, with others, seemed to demonstrate that ozonated air, *with sufficient concentration of ozone,* was a sterilizing agent. The importance of high concentration is seen when it is realized that the generating apparatuses lately exploited for domestic and similar uses give some 5 to 10 parts of ozone in a million of air compared with 7000 parts in a million for the tests noted. If only moderate claims for the use of ozone, as a commercial reagent of peculiar advantageous properties, can be made with apparatus giving extreme concentrations, then the falsity of extravagant and all-embracing claims for apparatus which gives homeopathic dilutions is at once evident.

The increasing activities of promoters of such extreme-dilution generators have led to certain medical studies of the action of ozone, which are abstracted elsewhere in this issue. These reports are of great interest and importance, but the reader should be advised at the outset that they have no bearing (except to emphasize what we have said above) on the utilization of ozone for commercial purposes, in truly high concentrations and under proper safeguards, as contemplated for the industrial services noted in our issue of Apr. 28, 1910.

Much has been said also of the wonderful therapeutic value of ozone and at least one hospital in this country has been equipped for the experimental use of charged air. Evidently these "values" have been mere hopes, the chief basis for which has been some general impressions of a tonic effect of ozone, and a popular belief that "bracing mountain air" owed its efficacy to the presence of this gas.

Of late there have been numerous schemes for doctoring up recirculated air in the ventilation of halls and school rooms. A few sets of tests have been made where the old air has been washed, cooled and slightly ozonated with apparently good results on the occupants of the room. This use of ozone has been apparently founded on belief in its reputed bactericidal and therapeutic values. The convincing testimony of the investigators mentioned above shows that ozone not only has no therapeutic value, but is positively detrimental to living beings long before concentrations are reached which have any bactericidal or deodorizing value. Therefore, it becomes a matter of concern to have public-health officials exclude ozone apparatus from use with ventilating systems wherever proposed.

National or State Control of the Gifts of Nature

The spectacular fight in the National Conservation Congress in Washington last week may well direct public attention toward the issue over which a battle was waged in the Hotel Willard's convention hall during nearly the whole of two days. That issue, stated in briefest form, is whether a State should exercise ownership and control of the natural wealth within its borders or whether the Federal Government should do this.

It is in the States of the far West that the problem is most acute and pressing. The demand of these States, as stated very frankly by the two Senators from Colorado in addresses before the Conservation Congress, is that the Federal government should turn over to the State the entire property which it owns there, lands, mineral deposits, forests and water power.

The argument is that in all the older States of the East those public lands were the property of the State, and in the Middle West the Federal government practically gave away the lands to the first settlers and the mineral and water rights to the first comer to claim or appropriate them. Colorado, Montana, Nevada and other Western states, therefore, demand that the same policy should be pursued now as in the past and that they should be given entire possession and control of the gifts of nature within their borders.

This demand, however, overlooks one vital factor; that is, that a vast change in public opinion has taken place during the past twenty years. The day has passed when any Government in this country, State or National, will be permitted by public opinion to part with the title to any of the gifts of Nature which still remain in public ownership save for a price representing a fair and reasonable value.

This does not mean, of course, that public opinion favors locking up these natural resources unused. It is well agreed that the ripe timber should be cut from the forest in such a manner that a new growth may spring up, that unused water power should be developed and

that coal mines should be opened and worked as fast and as far as the market demand justifies. Of course, if too high a price is set upon any of these sources of natural wealth it will operate to hinder their transfer to private ownership and act to a certain extent to delay development.

If the several States in which are located the forests and coal lands and water powers, still owned by the Federal government, were prepared to take them over and honestly administer them in the interest of all the people, then indeed there would be much to be said in favor of this policy.

It is, however, unfortunately true that the States, both East and West, have almost without exception so handled their original great possessions of land and mineral rights that nearly all have been transferred to private ownership with very little return to the State treasuries. In the far Western states, where the present strong appeal for State control arises, the State governments are very generally in control of men closely affiliated with large business interests and they are not in politics or in business for their health. Congress may be and often is a very poor custodian of the public interests; but vast progress has been made toward higher standards in the past two decades; and every well informed man knows that if the natural wealth of the far West still in public ownership is to be utilized for public benefit instead of given away to enrich private individuals, it should not be put into the power of Western State legislatures to dispose of, not just yet at least.

It was amusing to see that among the leaders in the fight for State control and ownership at the Washington Convention last week was Senator Bankhead, of Alabama who only a week earlier was leading the St. Louis Good Roads convention held to raid the Federal Treasury for $25,000,000 in aid of road construction. The Senator was vociferous in his appeal for State rights on the convention floor but there are no rights without corresponding duties. If the States are anxious for full control over those natural resources within their borders still under Federal jurisdiction, they should show their fitness for such control by wiser administration of the public roads, where their exclusive right to control is unquestioned.

What Is a Proper Allowance for Depreciation in a Sewerage System?

With all the discussion that has gone on in the last few years, regarding proper depreciation allowances in accounting, we recall little or nothing regarding the depreciation of sewerage systems. This is doubtless because sewerage works are almost without exception built by municipalities themselves, and they are in a large part paid for by assessments on abutting property. Other portions of sewer systems such as the trunk sewers and disposal works, however, are usually paid for by money raised by bond issues.

It is a universally accepted principle of sound financiering that the terms of a bond issue to pay for a public improvement should never be longer than the life of the improvement itself. It is a pertinent inquiry, from this point of view at least, how long the sewerage systems now being built are likely to endure. Probably most engineers designing and constructing a sewerage system, would say offhand that their work ought to last at least for half a century. It is doubtful, however, if the results of experience with sewerage systems built twenty years or more ago, justify the expectation of any such long term of life.

Some weeks ago (ENGINEERING NEWS, Oct. 18, 1913, p. 776) we published an account of a sewer failure which recently occurred in St. Louis, where a circular brick sewer, 5 ft. in diameter and 44 ft. below street level, collapsed and caused a cave-in extending clear to the surface of the street. While by good fortune no loss of life resulted, the property damage was large.

The most serious feature of all, and the feature of most interest to engineers, is the cause to which the collapse is assigned. The sewer was built in 1878, the bricks being laid in ordinary lime mortar, without cement. The mortar has been gradually disintegrating, and weakened the arch until collapse finally occurred. Similar causes have without doubt operated to cause great deterioration in all old brick sewers laid in lime mortar. Nor need we limit the damage to this class of work. The erosive effect of the flowing sewage, and the disintegrating effects of both the liquid and the sewer gases upon cement mortar as well have caused great deterioration, without doubt, in a large portion of the sewers laid upon cement mortar, which are more than a score of years old.

A large proportion of existing sewerage systems, too, have suffered more or less damage from other causes, such as unequal settlement during street excavation and the discharge of improper materials into the sewers. Of equal importance with physical alterations of the sewers themselves in increasing depreciation is the changing character of the population and the consequent demands upon sewer systems. If cities and towns were planned in advance on an intelligent system, it might be possible for a competent engineer to design a sewerage system which would be reasonably certain of fulfilling at all points the needs of a city of 40 years hence, as well as that of today. But our cities and towns have not been and are not being planned in advance of their growth. Centers of population and of manufacturing industry change in unforeseen directions. Cities are compelled all the time not merely to extend their sewerage systems with the growth of population, but also to revise the layout. Sanitary commissions and state legislation have compelled the outlay of many millions of dollars on long intercepting sewers, the need of which was hardly thought of 30 years ago.

When we come to works for ultimate disposal of sewage, a still shorter term of life must be assumed, if we would be on the safe side. The changing demands of the public and of state legislation and the courts, have rendered many sewage-disposal plants obsolete only a few years after they were constructed. We are building more wisely in these matters without doubt than did our predecessors a quarter of a century ago, but it is absurd to suppose that we have reached finality or to expect that the works now being constructed for sewage disposal may not be supplanted by something quite different within not more than 25 years.

The general public knows little of these matters but the engineer knows them or should know them, and should lend the strength of his opinion and influence, to the end that money borrowed for sewerage construction should be repaid in a short term of years.

LETTERS TO THE EDITOR

Improving Dirt Roads

Sir—Having just read your editorial in regard to improving country highways, I wish to say that in my opinion your ideas on this subject are thoroughly sound and agree with my own observations and experience. Some years ago when just a young man, I lived with my father, past whose farm ran a five-mile stretch of road connecting the county seat with a string of villages beyond. This road had been in use for more than a century, yet if it had ever been graded there was nothing to indicate it, except at places where it happened to cross bogs, etc., and fills had been made. In many places it was lower in the middle than at the sides and the traveled way was a trail which wandered from side to side and in some places ran on both sides and occasionally divided itself into three parts for short distances. Travel was heavy, yet little was done toward keeping up the road. In the spring, or perhaps after a series of exceptionally heavy rains, four horses would be attached to a steel blade and about an inch of loose dirt was scraped toward the center, which ground into dust when dry.

As we did a great deal of teaming with our business, my father had himself put in charge of this road and proceeded to grade it, plowing it up in the early spring and grading it from end to end. The work was thoroughly done and for two years the surface was dragged when needed, and as a result it was one of the best roads to be found anywhere. It was a good illustration of what can be done with an ordinary dirt road.

R. B. WHEELER.

White Plains, N. Y., Nov. 14, 1913.

"Human Engineering"

Sir—"Solving the Problem of 'Human Engineering,'" in the Nov. 13 issue of ENGINEERING NEWS, is one of the most inspiring articles I ever read. We see it stated occasionally that society is passing through grave economic changes whose importance and probable results reach far beyond the ken of man. In these changes it is possible that this "Human Engineering" may become a most potent influence in our social evolution.

When we have learned to do away with insincerity, with heartlessness and duplicity, in our relations with those who because of lesser opportunity must of necessity turn for advice and leadership to men by fortune more kindly favored, we may then look for a real enjoyment of the fruits of right living.

Men will be loyal to those whom they can trust, and whom they can trust they learn best by experience; when in a pessimistic vein it seems as if they rapidly were learning to trust no one. Yet there are, undoubtedly, many men entirely worthy as leaders to be trusted, and if this new development in college education swells their number and places these worthy men in positions of trust among our workers, their opportunities for the stimulation of better workmanship, of higher ideals and better living may lead to a solution of many of our most serious problems. An able leader with a goodly following of loyal workers presents an army that is invincible. It can build a Panama Canal or a transcontinental railway or perchance repel a foreign invasion.

To me, the method described appears to be the most helpful means of welding together our heterogeneous agglomeration of foreigners into a strong body of solid, loyal and patriotic citizens. Let the good work proceed. Give it the widest publicity and in a few years a great percentage of the present foremen and superintendents will have been supplanted by more efficient and successful men.

ALBERT J. HIMES.

Valuation Engineer, New York, Chicago & St. Louis R.R. Co.

Cleveland, Ohio, Nov. 15, 1913.

The Life of Supports for Wood-Stave Pipe

Sir—The very interesting article in your issue of Oct. 23, on the Puntledge River Power Development at Vancouver, B. C., has been noted and attention has also been directed to the editorial comment in the same issue on the life of supports for wood-stave pipe.

I agree with the statements in the editorial note about the desirability of designing for piecemeal replacement. Stave pipe, like any other structure, whether built on the ground or carried in chairs or cradles, must be cared for, and the life of the pipe itself, or of the chairs supporting it, depends on the amount of attention given toward preservation and upkeep. This matter of upkeep was recently brought to my attention by the condition of a wooden building about three years old. Boards were checking, outside porch floors were warping and opening up and the entire structure was showing the urgent need of attention. By the expenditure of $50 or $60 for painting, the deterioration was checked and the life and appearance greatly added to. This same need applies to a pipe line.

It has been our experience in building continuous-stave pipe that very few users care to go to the expense of treating the outside of the staves of the pipe or the chairs supporting it with any preservative, such as paint or carbolineum. Usually, after the pipe is installed and in use, it is never given a particle of attention, except where a bad leak develops. The life of chairs or supports could be materially increased if they were occasionally painted and looked after.

But at any event, if the life of the wood support is from seven to ten years, it still is the cheapest construction in the end. With proper design, the supports can be replaced as they give out and the difference in cost between the wood and concrete or other more permanent supports, will warrant the use of wood in most cases.

F. M. KIRSCH.

Manager, Pacific Tank & Pipe Co., Portland, Ore., Oct. 30, 1913.

How Far Must an Engineer Be Guided by His Client's Resources?

Sir—The destruction of property, loss of life and injury to business and living conditions wrought in Ohio cities by the floods of last spring are so fresh in the minds of everybody that the rejection at the recent election of plans for preventing flood damage in several cities in the future seems at first inexplicable. I have been able to learn some of the reasons for this adverse vote, and they bring up a basic problem in engineering practice.

The objection to the proposed plans has been almost wholly financial. Just as in Pittsburgh, where the cost of preventing flood damages is so high that both state and federal aid have been asked, the cost of some of the plans proposed for Ohio cities is considered beyond the limits of their resources. The regulation of stream-flow, the construction of levees and the removal of obstructions from a river channel are generally very expensive works, and when the total amount of work is great, it is almost impossible to raise funds for it.

This brings up the query, what is the engineer's duty under these conditions? Must he resolutely call for the perfect system which will prevent future damage, however costly it may be, or is he professionally justified in preparing less perfect plans which the community retaining him has sufficient resources to carry out?

It is contended by a number of eminent engineers that it is their duty to decide what is the best course for their clients and to adhere to this course just as firmly as a physician adheres to the orders he gives to a patient. This is particularly true, according to this school, where human life is involved. The advocates of this view have, I believe, been more prominent in advancing their opinions than have their opponents.

The second school of engineering is the practical one. It does not insist on the theoretically best plan for any given improvement, but aims merely to provide the best that is within the means of a community. This school would not design or approve an unsafe bridge or dam, which would be a constant menace to life; but it would look upon the prevention of flood damage in a different light from that in which those structures are viewed. This school of engineering practice holds that where a community settles on a flood plain, and continues to occupy the site after floods have revealed its dangers, it thereby relieves the engineer of part of his professional responsibility, for the most certain remedy for the dangerous conditions on the flood plain is to move elsewhere. That alternative to remaining in a dangerous location is not such a grave matter as it may seem, at least for a good many people.

If people choose to remain in a dangerous locality, and they have not money enough to remove all sources of danger, it would seem perfectly right for them to retain an engineer to help them secure such protection as their resources will provide. In fact, the second school of engineering holds that the only right course for it to follow is to point out what can be accomplished with moderate outlay. The recommendation of works calling for sums entirely beyond the resources of communities is condemned by those engineers as impracticable and consequently unprofessional. The recent Ohio elections indicate that there is considerable weight to this argument, for if any cities might be expected to spend money readily to prevent flood damages, they are those of Ohio.

JOHN M. GOODELL.

Upper Montclair, N. J., Nov. 14, 1913.

The Los Angeles Aqueduct: A Rejoinder

Sir—In your issue of Aug. 14, 1913, you published a letter from me regarding the Los Angeles Aqueduct and the cement made by the City of Los Angeles. In the same issue you published letters from Messrs. Hamlin and Lippincott in reply to my letter. Your indulgence is asked to correct misstatements made by Mr. Lippincott which tend to reflect on the writer personally.

The writer has not, as stated by Mr. Lippincott, any interest whatever in matters pending, or impending, between the City of Los Angeles and private power companies, nor is he, or has he been, employed as a witness by the California-Nevada Power Co. in any controversy between such company and the city. He was merely a witness as to facts in a suit between the Silver Lake Power & Irrigation Co. and the City of Los Angeles, because he had been professionally employed by the predecessors of this Power & Irrigation Co. at the time the water rights in question were initiated, and the ethics of the engineering profession would require that he should give the facts within his knowledge, under such conditions. He has no connection with any power company nor has he had any such connection since the termination of his last contract as consulting engineer for the Southern California Edison Co., in the latter part of the year 1911.

The writer has never been identified, directly or indirectly, with any labor troubles on the Aqueduct. He has personally supported certain candidates for office, who were supported by the labor organizations, merely because such candidates had, according to his judgment, assumed the correct attitude on civic questions against certain other candidates standing for the exploitation of the city by certain private interests. In pursuance of this policy, the writer supported Judge H. H. Rose for Mayor in the last campaign, as Judge Rose publicly stated that he would, if elected Mayor, correct the abuses surrounding the management of the Aqueduct work and other things previous to that time.

Mayor Rose, after his election, presented the writer's name to the old Council, as a member of the Police Commission. This was done while the writer was absent from the city in San Diego. Immediately upon his return, the writer withdrew his name, not being in a position to devote the necessary time to such an office, by reason of the requirements of his professional business. Had the writer desired to neglect his professional work to become a member of the Police Commission, this could readily have been accomplished for, if the old Council, some of whom were reëlected because no opposition ticket was presented for the City Council except by the Socialists, had refused to confirm the appointment, such a stand would undoubtedly have resulted in their recall under the charter provisions providing for such procedure.

F. C. FINKLE.

Los Angeles, Calif., Oct. 31, 1913.

Recent Investigations of the Bactericidal, Deodorizing and Physiologic Action of Ozone

The results of certain recent scientific investigations of the bactericidal, physiologic and deodorizing action of very low concentrations of ozone in air (more properly called dilutions) are now available, which seem to fill gaps in the available authentic information about the characteristics of this gas, for which so many extravagant claims have been made in the past 20 years. One of these studies has recently been completed by Drs. E. O. Jordan and A. J. Carlson, of Chicago, under a grant of funds from the American Medical Association. The second is by Dr. W. A. Sawyer, Director of the Hygienic Laboratory of the California Board of Health at Berkeley, assisted by H. L. Beckwith and E. M. Scolfield, Bacteriologists. Both reports are in harmony, and in agreement with similar work referred to, by Ohlmuller,[1] Erlandsen and Schwarz,[2] Filipow,[3] and Hill and Flack.[4] All of these several reports are unfavorable to many claims of domestic ozone-apparatus promoters.

The Jordon-Carlson and the Sawyer investigations are both reported in the *Journal* of the American Medical Association for Sept. 27, 1913. The Jordon-Carlson study was undertaken at the suggestion of the *Journal*, which was proffered advertisements of ozone apparatus, for the good of which clear evidence was lacking. The California study was undertaken because one of these machines had been excluded from an exhibit at an annual convention of the League of California Municipalities, which action was repeatedly protested with requests for laboratory tests.

THE CHICAGO TESTS—The ozonator used by Drs. Jordan and Carlson was rated to give 4250 cu.ft. of air per hour, and tests showed concentrations of 4 to 5 and 10 to 11 parts in a million, according to the adjustment of the machine. This is extreme dilution, compared with the concentrations secured with apparatus for serious commercial use where up to 8000 parts of a million or higher are produced. See ENGINEERING NEWS, Apr. 28, 1910. No oxides of nitrogen were found.

First, various usual disinfection tests with *staphylococcus p.a.* and *B. pyocyaneus* were made. Culture-soaked threads and filter-paper strips, were used variously—dry, moist, in envelopes, on petri dishes, and in cheesecloth sacks. Agar and gelatin plates were streaked with *B. coli* and *B. pyocyaneus* before and after exposure. "Controls" were used in every case to observe the action of similar unexposed specimens. The periods of ozone attack were varied up to five hours, with concentrations of from 3 to 4.6 parts in one million. No sure germicidal action could be seen from the varying results.

A series of tests were then made, with air bacteria. Dust in the experimenting room was stirred up and sterile agar plates were exposed for 25 minutes. Then a fan and the ozonator were variously used for an hour, when other plates were exposed. These actions were repeated in various ways. The plates, on being incubated for 24 hours, showed such slight and irregular variation of bacterial colonies that no effect of the ozone could be shown. Moreover, the amounts of ozone used were beyond human physical tolerance.

The deodorizing properties of ozone were studied in a room of 26 cu.m. contents having provision for renewing the whole volume of air from once in 30 minutes to once in 12 hours. There were used as odorous substances ammonia vapor, hydrogen sulphide, oil of cloves, asafetida, human feces, decomposed urine, decomposed meat, and rose and lilac perfumes. Comparable concentration of the odors was sought by evaporating fixed quantities of material each time and by exposing equal quantities of such odorous substance for equal time. The "control," for comparison, was secured by noting the normal disappearance of odor under uniform ventilation. The ozone tests were made to find three things: (1) the concentration required to mask the odors; (2) the possible destruction of odorous substance by ozone in strong concentrations; (3) possible destruction of odorous substance with ozone concentrations just sufficient to mask the odor.

With the exception of ammonia and oil of cloves, all the odors noted were completely masked by a concentration below one part in one million. These two were masked only by concentrations which cause marked irritation and headache after short exposure.

When the ozonator was run just long enough to mask the trial odor, the ozone odor disappeared first and the rate of disappearance of the other was the same as in the control period, showing no destruction of odor substance by the ozone.

With 2 to 5 parts per million the rate of disappearance of odors of feces, stale urine and decomposing meat was hastened somewhat, showing some destruction of odor substance. With all the other odors there was no destruction with up to concentrations of 5 parts ozone in a million—as far as the test ran. The failure to oxidize ammonia and oil of cloves was strikingly illustrated by masking them three or four times in succession during a single test, the specific odor outlasting the ozone.

The masking of odors by ozone is explained by these investigators as (1) the preponderance of peculiar ozone smell in the consciousness and (2) a fatigue or even anesthesia of the olfactory organs.

By experimenting with small mammals, ozone was found to be an intense irritant to the respiratory tract and other mucous membranes, causing death from edema of the lungs (swelling by discharge of fluids from blood vessels into intercellular spaces of tissues).

Dogs and rabbits were made to breathe through a tracheal tube instead of through the nose and larynx, and were subjected to ozonated air (10 parts in one million), together with animals breathing normally. With the direct tracheal breathing it took only 30 minutes exposure to develop the same edema and congestion as in normal animals exposed two hours. There was thus evidence that three-fourths of inspired ozone is decomposed by the membranes of the upper air passages, and that the exterior conditions are no measure of the ozone concentration at the lung tissues.

The depression and drowsiness reported by earlier observers were shown by the animals in these studies. Further studies on animals with their vagus nerves cut gave evidence that this state was largely due to afferent nervous impulses upon the brain from the irritated respiratory tract; changes in the metabolism and possibly (in-

[1]Arb. a. d. k. Gsndhtsamte, 1893, VIII, 229.
[2]Ztschr. f. Hyg. u. Infectionskrankh, 1910, LXVII, 391.
[3]Arch. f. d. ges. Physial, 1884, XXXIV, 335.
[4]Proc. Royal Soc. Series B, 1912, LXXXIV, 404.

directly) in the composition of the blood were held capable of causing such an effect also, especially after prolonged exposure to ozone.

The usual headache of observers exposed was also experienced, coming on during or shortly after brief exposure and persisting sometimes for two to six hours. This was always a frontal pain similar to that of a "head-cold." It was believed to be due to irritation of the gas and consequent blood congestion at the frontal cavities, conditions which were actually found in animals.

Breathing mixtures up to 10 parts per million for not over 15 minutes total time, produced a sore throat which persisted for two or three days and was occasionally accompanied by pain in the chest—all due probably to corrosion of mucus membranes. One of the observers had a sore throat and cold, but the ozone actually aggravated the symptoms, contrary to the claims which have been advanced by promoters.

The foregoing tests were with ozone concentrations which the investigators believed might be used in experimental therapeutics. They continued work, however, at the much greater dilutions (1 in 5,000,000 to 1 in 20,000,000), which would not be positively disagreeable in ventilation work.

It had been previously noted (by Hill & Flack) that ozone decreases gaseous exchange in the lungs before there is any demonstrable injury to tissues, and with concentrations too low to produce inflammation and edema. It was admitted that reliable evidence of favorable or unfavorable action of ozone in dilutions of less than one part in a million were difficult to obtain, since the animal organism is capable of repairing slight injuries. However, four cats, four rabbits, six guinea pigs and twelve rats were placed in comfortable cages in a room of 26 cu.m. capacity, adjusted to have a complete change of air once in two hours. Various refinements for ventilation, distributing ozone, taking air samples, observing animals, etc., were made. These animals were confined in the room for two weeks, without ozone, and then for two weeks with the machine running for five minutes in each 30, during nine hours a day. The ozone varied from 1 part in a million to a dilution just detectable by odor. Body weight, appetite and general condition were observed. All the animals exhibited an increase in body weight, but practically the same in the control period as in the ozone exposure. There appeared to be no effect on appetite or general condition. The cats did not appear disturbed when the ozone concentrations approached 1 part in a million, but the rabbits, rats and guinea pigs were restless. The investigators urge that lack of harmful effects in these short periods should not give sanction to use of dilute ozone in practical ventilation work where the workers may be exposed similarly for 9 to 12 months a year during a lifetime. They ask at the close of their report:

> Is such masking of odors desirable and generally advantageous? We think not. . . . Except in special industrial processes, the unpleasant odor of the inspired air in shops, factories or living-rooms is usually a sign that the air needs to be renewed or changed as regards not only the percentage of odorous substances, but also, and of greater importance, the percentage of moisture and the degree of temperature. Why should we put out of commission the sense organ, which aids us in determining whether or not the air is fit to breathe? It seems to us that this is wrong in principle, and that ozone is being used and will be used as a crutch to bolster up poor ventilating systems. Ozone does not make "pure air" any more than strong spices make pure food. . . . The "tang" is a combined effect of ozone odor and the ozoneirritation of the sensory nerves in the respiratory tract. We have seen that this acts (reflexly) on the vascular mechanism and it may temporarily "whip up" a fagged brain. But is this ozone tang any more beneficial or any more physiologic than a whiff of smelling-salts or a puff of cigarette? We recognize that a certain amount of variation in the rate of movement and in the temperature of the air about us aids in maintaining the tonus of the brain, but our ventilation engineers must reproduce the variability of outdoors by actual variations in the air and in the rate of movement of the air in the ventilating systems, and not by adding a poisonous gas to the air. . . .

California Report—On account of the protests against exclusion of ozone machines from a public health exhibition as already noted, a few simple experiments were made with machines of two well known concerns to show the relative killing power on animals and bacteria. No attempt was made to measure the concentration of ozone or the oxide of nitrogen.

Machine "A" was intended for our use in a large room containing some 15 persons; it had no fan. Machine "B" was also intended for purifying the air of the large room and it included a motor-driven fan for forcing air through the apparatus into the room. In testing a machine, it was placed in a tight wooden cabinet, of 1 cu.m. contents, having a glass window. Humidity was indicated by wet- and dry-bulb thermometers; the amount of moisture in the air was increased in some experiments by pouring hot water through a tube into a dish inside. Guinea pigs to be subjected to the ozone were placed in a small wire cage where they could be seen from the window. Glass rods with dried bacterial cultures were fixed in large corks and inserted through holes in the top of the box. The organisms employed were *staphyloccus p.a.*, *streptococcus a.*, *B. Typhosus*, and *B. subtilis*.

The animal and bacteria tests with the first machine were carried on separately but simultaneously with the second machine and both with and without moisture.

In the tests of machine "A" the guinea pig seemed sluggish and was breathing rapidly at the end of an hour. Necropsy showed marked edema of the lungs. The *staphyloccus* culture was sterile after three hours in one trial and after four hours in another; the *B. typhosus* was sterile after five and six hours, but the *B. subtilis* was not killed in eight hours.

In the first test of machine "B," the guinea pig showed labored breathing in 20 minutes; at 45 minutes it was drowsy; in an hour its eyes were watery and almost closed; in 1 hr. 30 min. its breathing was irregular and spasmodic, and followed by convulsive movements; in 1 hr. 40 min. it was struggling for air; and in 1 hr. 55 min. it was dead. Necropsy showed marked edema of the lungs. All the guinea pigs in the experiments which followed showed similar symptoms and edema.

Where moisture was added to the air in the tests with machine "B," the *streptococcus* culture was sterile after three hours; the *staphyloccus* after four hours; the *B. typhosus* after four hours; but the *B. subtilis* was not killed. Without the addition of moisture the *streptococcus* culture was sterile after 12 hours; the *staphyloccus* and the *B. typhosus* after 8 hours; but *B. subtilis* was not made sterile.

A fourth test of machine "B" was made with the machine running at its lowest strength instead of its highest as before. No moisture was added to the air and the average humidity estimation was 62.9%. The four kinds of bacteria withstood 12 hours exposure, while the guinea pig died after 1 hour 25 minutes.

Additional tests were performed in two bedrooms in a dwelling house. A room containing 730 cu.ft. contents was prepared by packing the spaces about the windows and doors with cotton. A similar room was prepared for exposing control cultures to the drying influence of air.

In testing the ozone machines in this room, the same varieties of bacteria were exposed as before and in similar ways. Machine "A" was run at maximum strength for 16 hours in the closed room. When the room was opened sub-cultures were made and the organism grew in every case. Machine "B" was run at its maximum strength for 16 hr. in the same room; the cultures all survived, but a guinea pig was found dead when the door was opened. Necropsy showed edema of the lungs.

During these several tests the experimenters, after working around the machines and inhaling the diluted gas, experienced a feeling of dryness or irritation in the nasopharynx and sometimes irritation in the chest. With prolonged exposure, watering of the eyes and a slight headache resulted. The smell of ozone and the irritation were much more noticeable to persons coming suddenly under its influence than to those continually exposed.

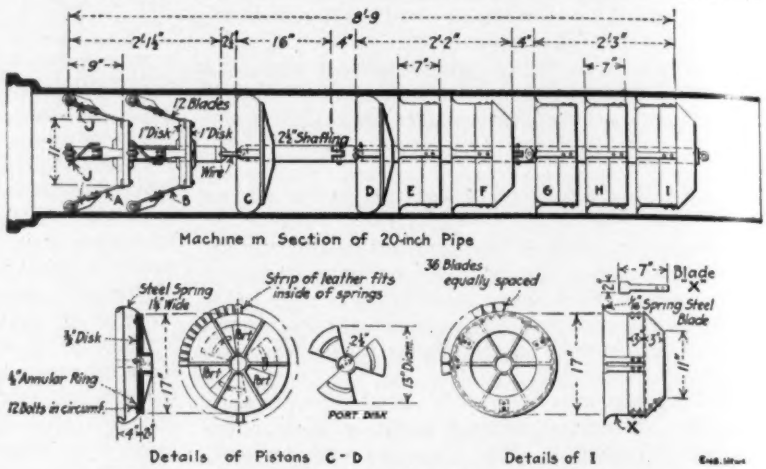


FIG. 1. PIPE-CLEANING MACHINE FOR 20-IN. PIPE; OWNED AND OPERATED BY THE NATIONAL WATER MAIN CLEANING CO., NEW YORK CITY

Note:

E same as **I**, without head part and blades not toothed.
F same as **I**, except blades not toothed.
G same as **I**, without head part and blades not toothed.
H same as **I**, without head part, but with blades toothed.
G, H and **I** have blades turned in, as well as out, for stiffness.
C, D and **G** are loose on shaft. Others are keyed to shaft.
J off-cast scrapers.

Cleaning Water Mains at Hartford, Conn.*

By CALEB MILLS SAVILLE†

The city of Hartford, Conn., is supplied with water by gravity through three mains about 6½ miles long, two 20 in. and one 30 in. in diameter. The first main laid was cement lined, and was put into service in 1867. On account of frequent breaks, portions were replaced from time to time with cast-iron pipe until now this is wholly cast iron. Although the older in point of original location, this main is actually the lesser in age of the two 20-in. mains. In speaking of this main hereafter, it will be known as the south 20-in. main. The other 20-in. main, known hereafter as the north 20-in., was laid in 1875 and is, therefore, about 37 years old. The 30-in. main was laid in 1896 and is 16 years old.

The maximum rate of consumption at any period during the day, in 1912, was about 13,700,000 gal., while the minimum flow from midnight to 5 a.m. was at a rate of 4,500,000 gal. per day. The drop in pressure at City Hall due to this difference in rate was 18 lb. before cleaning, and the gain due to the cleaning of one 20-in. main is estimated to be from 2 to 3 lb., the actual loss with the same flow under present conditions being from 15 to 16 lb. For the preliminary study simultaneous measurements were taken in all three of the mains at the time of average daily flow.

Previous to these tests the 30-in. Venturi meter on the supply line and the pitometers used in the work were checked against each other, the pitometers being found to read about 1.5% in excess of the meter reading. The results of the tests on the mains have been summarized and are given in Table I, together with certain comparisons that relate to age, carrying capacity and present conditions of these supply mains.

Note—Date of laying south 20-in. main is date original main was laid.

From the table it is seen that the coefficients (Column 3) for the 30-in. and the north 20-in. main were unusually low, while the south 20-in. main was in about the condition that might have been expected. If these pipes were cleaned, it was estimated that the present system would be capable of delivering 20,000,000 gal. per day to the city with the same loss of head that then existed (18 lb. at City Hall); and, if not cleaned, it appeared that under present conditions of demand the construction of a new main would be an immediate necessity.

Using the consumption figures from the Venturi meter record for June, 1912, the following estimate of future consumption was made: Average rate, 9,130,000 gal. per day and maximum rate, 14,500,000 gal. per day, or 58% excess maximum to average rate. With an average annual rate of increase of 500,000 gal. per day in five years the additional amount required would be 11.63 m.g.d. and 18.4 m.g.d., respectively, for average and maximum drafts. Therefore, if the above assumptions are correct, the present system restored to its original capacity should be good for five years more, even with a rate of deterioration twice that usually assumed.

If a new supply pipe were laid, it would have to be at least 36 in. in diameter and about 33,000 ft. long (about 6¼ miles). At a minimum price of $8.25 per lin. ft., this line would cost about $270,000, the interest on which at 5% simple interest would be $13,500 per year and at compound interest the charge would be $74,500 in five years.

The preliminary estimate for cleaning three miles of 30-in. and six miles of 20-in. was $15,300, a little more than the interest for one year on the amount necessary to lay a new 36-in. main. If, therefore, the construction of the 36-in. main could be postponed for five years without detriment to the service, the saving to the city was estimated to be about $60,000.

On account of the benefit which would result to the city

*Abstract of a paper read at the Nov. 12, 1913, meeting of the New England Water-Works Association, to be published later in full in the "Journal" of the Association (Secretary, 715 Tremont St., Boston, Mass.)

†Chief Engineer, Board of Water Commissioners, Hartford, Conn.

TABLE I. RESULTS OF TESTS OF THE CAPACITY OF WATER MAINS, HARTFORD, CONN.

Diameter, in.		When laid	Coefficient for Kutter's Formula (Weston) Existing	According to age	New laid or cleaned	Discharge in m.g.d.—loss of head, 18 lb. Present	New laid or cleaned	After 10 yr.	Age As per coef.	Actual
30		1896	81.6	91.5	112	8.5	11.7	10.2	28	16
(No.) 20		1875	63.4	75.7	110.8	2.4	4.2	3.7	65	37
(So.) 20		1867	74.0	75.0	110.8	2.8	4.2	3.7	40	25–40
						13.7	20.1	17.6		

if it were possible even partially to restore the carrying capacity of the existing mains by cleaning them, information was sought from various cities where the process had been applied. Very courteous and complete replies were received, and there seemed to be a unanimity of opinion that the work done was satisfactory.

The list prices quoted by the National Water Main Cleaning Co., of New York City, for doing work in the distribution system were:

PRICES PER LINEAR FOOT OF PIPE

6-in. pipe—16c.	12-in. pipe—22c.	24-in. pipe—40c.
8-in. pipe—17c.	16-in. pipe—26c.	30-in. pipe—65c.
10-in. pipe—18c.	20-in. pipe—30c.	36-in. pipe—80c.

These were stated to be for average conditions for lengths of five miles or more, given only for purposes of preliminary estimate. In Hartford a price of 28c. per lin.ft. for 20-in. pipe was given for a three-mile contract, with a further reduction if a greater length was cleaned.

The conditions were exceedingly favorable for a large part of the way on account of few consumers on the line, advantageous location of gate valves and blowoffs for cutting out sections of proper length and also because of a parallel main

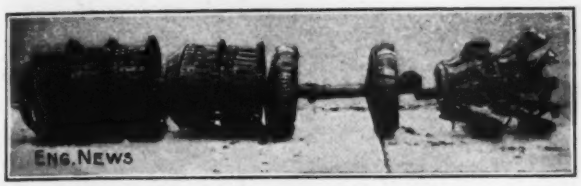


FIG. 2. PIPE-CLEANING MACHINE USED ON 20-IN. MAINS, HARTFORD, CONN.

with cross-connections which gave ample water for operating the machine without interference with the city supply.

A contract was entered into Sept. 4, 1912, with the National Water Main Cleaning Co. to clean, on trial, three miles of 20-in. pipe, and if satisfactory results were obtained the cleaning process might be continued through several miles additional of 20-in. and three miles of 30-in. pipe.

Work was begun Sept. 6 and suspended on Oct. 24 on account of the scarcity of water in the reservoirs. The results were very satisfactory, and during this period (49 days) a total of 33,093 lin.ft. (6¼ miles) was cleaned. On this section there was 154 service pipes which were shut off during cleaning; and only four were at all interfered with by the cleaning operations. Three of these were extension meters located at the street line with no curb cocks, and it was necessary to remove the meter and clean out the dirt. The other service affected was plugged, but was easily relieved by a force pump.

The usual force employed on this work was a superintendent, a foreman, a calker, 14 laborers and a double team for carting pipe materials and supplies. Under average conditions 3000 lin.ft. was found to be the maximum effective length for cleaning. If the machine is drawn through by a cable, the length of section is from 500 to 1200 ft. It is stated by the contractor that the machine can be operated by water under heads of as low as 10 or 12 lb. The least available head on the Hartford mains was somewhat greater than this.

THE PIPE-CLEANING MACHINE—The machine used in cleaning the mains consisted of three distinct sections attached to each other by a flexible joint in the connecting shaft, which is central in all of the sections. These joints move readily and allow the machine to pass through ordinary water-pipe curves if the radius is not too short. The first section consists of three spiders fastened to the shaft; these are armed with saw-tooth blades that project at right angles to the axis of the machine. The function of these blades is to cut up and tear loose incrustation and scale that adheres to the pipe walls (see Figs. 1 and 2).

The second section is made up of two spiders armed with smooth scrapers. The function of these blades is to scrape away all matter left clinging to the pipe by the first section.

Behind these two sections is a double piston fitting the pipe very closely, with leather gaskets pressed out by steel springs, which are continuous around the entire circumference. The pistons are fitted with dampers which can be adjusted to the pressure of water and so regulate the quantity needed to wash ahead the scale and other matters cleaned from the pipe. Behind each spider and loosely fitting on the center shaft are three somewhat flexible metal disks whose function it is to deflect the wash water toward the pipe walls and out through the cleaning blades where the high velocity helps remove some matter and keeps the whole mass moving along with the machine.

Behind the pistons is another section which carries two rows of right and left off-cast scrapers. These are very heavy and are designed to smooth off the surface and leave a clean smooth water way. These blades are allowed only just to touch the pipe walls, their position being kept by case-hardened rollers that run on the pipe wall. The gross diameter of the machine used for the 20-in. mains is 21½ in., the steel springs letting down at entrance and so keeping the machine firmly centered in the pipe. The steel blades are made especially for this purpose, and are nearly all replaced after each draw. This replacement, of course, depends largely on the character of the incrustation, and when mud alone is found the blades may require very little renewal.

INCREASES IN CAPACITY OF PIPES—Previous to the cleaning work a very thorough survey was made of the capacity of the pipe line by the use of the pitometer, and similar tests were made after the work was finished. A typical summary of the results of this work is given below (see also Fig. 3):

Pipe cleaned—north 20-in. main, Farmington Ave.
Section—reservoir No. 1 to Vanderbilt Hill
Length—1st test, 16,400 ft. 2nd test, 14,650 ft.
Pipe laid in 1876. Age, 37 years. Kind, cast-iron

	(1)	(2)
Date of test	Aug. 22, 1912	Oct. 2, 1912
Make of gage	Crosby	American
Unit of gage	1 lb.	1 ft.
Head lost	20 ft. to 55 ft.	20 ft. to 50 ft.
Range of velocity (ft. per sec.)	1.69 to 2.40	2.84 to 3.97
Possible error	Per lb., 3.5%	Per ft., 1.5%
Mean coefficient (Chezy formula)	69	111
Increase in capacity	61%	....
Average coefficient in Chezy formula... Weston (37 years)	75 (new) 111	
Williams and Hazen (37 years)	76 (new) 116	

The loss of head was about the same in both cases, and sufficiently large so that an error of 1 lb. or 1 ft. would be comparatively negligible.

The north 20-in. main was cleaned from the reservoir to Union Place, a distance of about five miles. The south 20-in. main has been cleaned from the reservoir east about 1¼ miles. Tests of the flow made before and after cleaning, indicated that in both pipes the carrying capacity had increased sufficiently to compare with Weston's tables for new 20-in. pipes. This is equivalent to a coefficient of 111 in the Chezy formula, the resulting increase in capacity being 61% and 50% respectively, for the north and south 20-in. mains.

Several readings of the amounts of water used during the cleaning were made from the records of the Venturi meter at the reservoir gate-house, and 50 gal. is believed to be a reliable estimate of the amount per lin.ft.

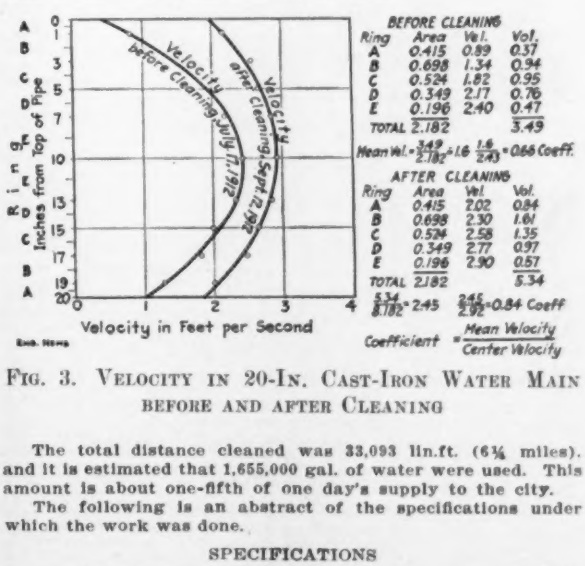

Velocity before Cleaning, July 31, 1912
Velocity after Cleaning, Sept. 12, 1912
Inches from Top of Pipe
Velocity in Feet per Second
BEFORE CLEANING
Ring Area Vel. Vol.
A 0.415 0.89 0.37
B 0.698 1.34 0.94
C 0.524 1.82 0.95
D 0.349 2.17 0.76
E 0.196 2.40 0.47
TOTAL 2.182 3.49
Mean Vel. = 3.49/2.182 = 1.6 1.6/2.43 = 0.66 Coeff.
AFTER CLEANING
Ring Area Vel. Vol.
A 0.415 2.02 0.84
B 0.698 2.30 1.61
C 0.524 2.58 1.35
D 0.349 2.77 0.97
E 0.196 2.90 0.57
TOTAL 2.182 5.34
5.34/2.182 = 2.45 2.45/2.92 = 0.84 Coeff
Coefficient = Mean Velocity / Center Velocity

FIG. 3. VELOCITY IN 20-IN. CAST-IRON WATER MAIN BEFORE AND AFTER CLEANING

The total distance cleaned was 33,093 lin.ft. (6¼ miles), and it is estimated that 1,655,000 gal. of water were used. This amount is about one-fifth of one day's supply to the city.

The following is an abstract of the specifications under which the work was done.

SPECIFICATIONS

(1) The Contractor shall provide the necessary tools, appliances, labor and materials to perform and complete this work in an expeditious manner. The work to be done shall consist of excavating, cutting pipe to be cleaned, cleaning the pipe so as to remove rust, tubercles, organic growths, deposits, silt, and other foreign material due to the presence of water in the mains, reconnecting the pipe, and refilling the excavations.

(2) The Contractor shall make all necessary excavations for the execution of the work. The materials excavated from the openings thus made shall be placed in such a position as

not to impede travel on the railroads, or unnecessarily impede the travel on the streets in which the openings are made.

(3) The Contractor shall take proper precautions to support and sustain the sewers, conduits, water and gas mains laid in or across the streets which may be liable to injury or damage from digging the openings herein mentioned, and have a sufficient quantity of timber and plank on the ground when necessary to use the same as required. All sheet plank and timber used during the progress of the work to support the sides shall be removed as the filling proceeds.

(4) The Contractor shall refill the openings and remove all surplus material. The openings thus made shall be filled with suitable material, put in horizontal layers not over 6 in. thick, and each layer thoroughly rammed so as to render the whole filling solid and compact.

(5) The Contractor shall maintain at all openings made by them such guards and lights as may be necessary to prevent accident or injury to the person or property of others; and shall indemnify and save harmless the Water Department against any and all suits and actions brought against it, and from all damages, costs and expense to which it may be put by reason of any negligence or carelessness in the performance of the work, or in guarding same, or by or on account of any act or omission of the Contractor, or his agents; except as herein specified and provided.

(6) The Water Department shall furnish right-of-way and permits where same are necessary for breaking of pavements.

(7) The Water Department shall notify all consumers in advance of shutoffs and shall assume all responsibility for such shutoff and save the Contractor harmless from all damages, costs and expenses incurred by reason of injury or damage to the person or property of another as a result of shutoffs.

(8) On completion of the cleaning of each separate section the Water Department shall make immediate inquiry of each consumer as to any stoppage of flow in service pipes and the Water Department shall immediately notify the Contractor of any such stoppage, and the Contractor shall at once remove any stoppage due to said cleaning operation. The house services shall have been shut off at the curb or just inside the cellar wall, by the Water Department so far as possible, before the cleaning operation shall have been commenced, and should the Water Department fail to notify the Contractor of any such stoppage within one week from the time the water is turned on to the section where such stoppage occurs, the Contractor shall not be held responsible nor be required to repair same.

(9) The Water Department shall not hold the Contractor responsible for cutting pavements or excavations when due to incorrect maps or information as to the size and location of pipes, and the Contractor shall be reimbursed for extra labor entailed thereby, plus 15% for contingencies.

(10) The Water Department shall also reimburse the Contractor for the actual cost and expense entailed in cutting pavements, making excavations, cutting and replacing mains to remove the cleaning equipment when same becomes necessary as a result of defective joints, surplus lead, bends, offsets, or special fittings which do not conform to the size of the main being cleaned, or are not shown on the plans.

(11) The Water Department shall furnish one or more competent men to take charge of all shutoffs, and to promptly make such shutoffs when requested by the Contractor or his representatives.

(12) The Contractor shall notify the Water Department when shutoffs are wanted.

(13) The Water Department shall coöperate with the Contractor and assist in expediting the work of the Contractor, by giving prompt shutoffs whenever requested by the Contractor, and furnishing normal pressure in the mains and when necessary and possible to give higher pressure.

(14) The Contractor shall coöperate with the Water Department and assist them whenever possible to accommodate their consumers.

(15) The Water Department shall not hold the Contractor liable for any damages caused to its gates, valves, or hydrants by reason of their necessary operation in making shutoffs, or their operation under the direction of the Water Department.

(16) The Water Department shall repave all openings for the cleaning and shall be responsible for such repaving.

(17) The Contractor shall make regular detailed statements of all overtime or extra materials which may be chargeable to the Water Department, giving the cost of materials and rate of pay of its employees plus 15% for contingencies.

(18) The Contractor shall assume responsibilities for any claims made against the Water Department for any infringement of patents by the use of patented articles in the execution and completion of the work, and shall indemnify the Water Department for all costs, expenses and damages which the Water Department shall be obliged to pay by reason of any infringement of patents used in said work.

(19) Any damage done to the mains at joints where cuts shall have been made for the cleaning work, shall be repaired and made fairly secure and tight by the Contractor so as to be in first-class serviceable condition at the completion of the work.

(20) In reconstruction, the Contractor will use such classes of pipe and special castings conforming to the New England Water-Works Standard, as may be designated by the Chief Engineer.

(21) So far as possible, the work to be done nights and Sundays in order to avoid annoyance to consumers.

❋

A Monument to the Inventor of Nitroglycerin has been erected at Casale Monferrato, Italy, by private parties. Ascanio Sobrero, born 1813, discovered nitroglycerin in 1847. The monument is in commemoration of his hundredth birthday anniversary [Schweizerlische Bauzeitung, Oct. 25, 1913].

Failure of Partially Constructed Groined Arch Roof, Baltimore, Md.

By Ezra B. Whitman*

Extensive improvements in the water-supply of Baltimore City are being made at the present time. A large impounding reservoir is being built to increase the water-supply and a mechanical filtration plant is being built to improve the quality of the water.

In connection with the filtration plant, twin reservoirs are being built for the filtered water, each reservoir having a capacity of approximately seven and three-quarter million gallons. The reservoirs are each 241 ft. wide by 258.5 ft. long and have a total depth from the floor to the inside crown of the groined arches above of 20 ft. The reservoirs are designed with the view of having the high-water line 17 ft. above the bottom of the reservoir or at the spring line of the groined arches.

The reservoirs are covered with groined arches and are built of plain concrete with the exception of the division wall between the two reservoirs, which is reinforced. This division wall is 2 ft. 3 in. thick at the bottom and 18 in. thick at the spring line of the groined arches. The thrust at the top of the wall is transmitted through barrel arches to the groined arches beyond.

The outside walls of the reservoir are of the barrel-arch type and the section of this wall is similar to that used for the walls of large aqueducts or sewers and is designed to transmit the thrust through the arch and abutment section to the foundation below. The arch of the outside wall has a thickness of 6 in. at the crown where it abuts against the groined arches.

The groined arches have a clear span of 13 ft. 6 in. from pier to pier and a rise of 3 ft. At the crown the thickness of the arch is 6 in. and the depression over the piers is 21 in. The curve forming the underside of the arch is semielliptical, while the upper surface of the groined arch forms a parabola.

The floor of the reservoirs has a total thickness of 8 in., being made in two layers, each 4 in. thick, except near the outer walls, where the layers are somewhat thicker, as shown in Fig. 1. The concrete in each layer of the floor is placed in blocks of approximately 15 ft. square.

The concrete piers carrying the groined arches are 18 in. square and are carried on bases 5 ft. square, which bases are reinforced with steel and placed on the lower layer of the floor.

The construction of the roof over the filtered water reservoirs was begun at the north wall and the barrel arch along this wall and three rows of groins were completed. Nine other groins were completed near the east wall, as shown on the accompanying drawing (Fig. 1). The plans called for an earth covering along the east wall of the reservoirs 2 ft. 3 in. in depth above the outside crown of the arches, diminishing to a depth of 1 ft. 9 in. on the west side of the reservoirs. The forms were removed from under the completed groins with the exception of a small portion at the east and west ends as indicated inside the dotted lines upon the accompanying drawing. These forms had been moved south and

*Water Engineer, Baltimore, Md.

TABLE I. DATA RELATING TO GROINED ARCHES WHICH HAVE BEEN BUILT IN THE UNITED STATES AND CANADA

Date Completed	Location	Structure	Total Area in Acres	Depth of Earth Cover	Concrete Mixture	Groined Arches Span	Groined Arches Rise	Groined Arches Crown Thickness	Piers Size	Piers Depression Above
1903	Yonkers, N. Y.	Filtered water reservoir	0.06	4′ 0″	1 : 2.9 : 5	10′ 0″	1′ 6″	6″	16½″x16½″	9½″
1903	Watertown, N. Y.	Coag. basin and reservoir	0.40	2′ 0″	1 : 2.9 : 5	10′ 0″	1′ 6″	6″	18″x18″	10″
1909	Providence, R. I.	Filters	10.00	2′ 0 ″	1 : 2½ : 5	10′ 3″	2′ 6″	6″	20″x20″	15″
1903	Ithaca, N. Y.	Coag. basin and f. w. res.	0.25	2′ 0″	1 : 2½ : 4½	10′ 6″	1′ 6″	6″	18″x18″	10½″
1912	Grand Rapids, Mich.	F. w. res. under mech. filters	0.22	none	1 : 2 : 4	10′ 6″x10′ 4″	2′ 9″	9″	24″x24″	none
1900	New Orleans, La.	Filtered water reservoir	3.74	1′ 0″	1 : 2½ : 5½	10′ 8″	2′ 6″	6″	16″x16″	.....
1907	Cincinnati, Ohio.	Supports under mech. filters	1.05	none	1 : 2½ : 5	11′ 0″x9′ 5½″	2′ 6″	8″	21″x21″	none
1909	Springfield, Mass.	Filters	3.12	2′ 0″	1 : 3.1 : 5.3	11′ 4″	2′ 0″	6″	20″x20″	15″
1911	Toronto, Ont.	Filtered water reservoir	2.23	2′ 0″	1 : 2½ : 4½	11′ 4″	2′ 0″	6″	20″x20″	14″
1911	Toronto, Ont.	Filters	10.08	2′ 0″	1 : 2½ : 4½	11′ 4″	2′ 0″	6″	20″x20″	14″
1910*	Owen Sound, Ont.	Filters	0.49	.....	.....	11′ 6″	2′ 6″	6″	18″x18″	14″
1905	New Milford, N. J.	F. w. res. under mech. filters	0.25	none	1 : 2½ : 5	11′ ″x9′ 8″	2′ 6″	8″	24″x24″	none
1903	Washington, D. C.	Filters	5.18	2′ 0″	1 : 3.1 : 5.3	11′ 10″	2′ 6″	6″	22″x22″	17″
1908	Columbus, Ohio.	F. w. res. under mech. filters	0.53	none	1 : 2½ : 5½	11′ 10″x9′ 8″	2′ 6″	8″	24″x24″	none
1913	Minneapolis, Minn.	F. w. res. under mech. filters	0.38	none	1 : 2 : 4	11′ 10″x10′ 10½″	3′ 0″	9″	26″x26″	none
1899	Albany, N. Y.	Filters	5.74	2′ 0″	1 : 3 : 5	11′ 11″	2′ 6″	6″	21″x21″	6″
1897	Wellesley, Mass.	Reservoir	0.12	2′ 0″	1 : 2½ : 4½	12′ 0″	2′ 6″	6″	24″x24″	none
1900	Superior, Wis.	Filters and reservoir	0.59	2′ 0″	1 : 3 : 5	12′ 0″	2′ 6″	6″	20″x20″	6″
1903	Brookline, Mass.	Reservoir	1.4	1′ 9″	1 : 2 : 4	12′ 0″	2′ 6″	6″	20″x20″	none
1910	Wilmington, Del.	F. w. res. under final filters	2.11	none	1 : 3 : 5	12′ 0″	3′ 0″	9″	24″x24″	none
1905	New Milford, N. J.	F. w. res. under building	0.10	none	1 : 2½ : 5	12′ 0″x11′ 8″	2′ 6″	8″	24″x24″	none
1913*	Montreal, P. Q.	F. w. res. under pre-filters	0.65	none	1 : 2½ : 5	12′ 0″x10′ 3″	3′ 0″	8″	30″x30″	none
1913*	Montreal, P. Q.	F. w. res. under future pre-filters	1.35	3′ 0″	1 : 2½ : 5	12′ 0″x10′ 3″	3′ 0″	8″	30″x30″	none
1913*	Montreal, P. Q.	Filtered water reservoir	0.23	3′ 0″	1 : 2½ : 5	12′ 0″x10′ 3″	3′ 0″	8″	30″x30″	21″
1913*	Montreal, P. Q.	Supports under pre-filters	0.53	none	1 : 2½ : 5	12′ 0″x10′ 3″	3′ 0″	9″	30″x30″	none
1899	Clinton, Mass.	Reservoir	0.18	4′ 6″	1 : 2½ : 4	12′ 0½″	2′ 6″	12″	30″x30″ / 24″x24″	none
1903	Washington, D. C.	Filters	23.72	2′ 0″	1 : 3 1 : 5.3	12′ 2″	2′ 6″	6″	22″x22″	17″
1909	Yonkers, N. Y.	Filters	1.55	2′ 0″	1 : 3 : 5	12′ 2″	2′ 6″	6″	22″x22″	
1899	Concord, Mass.	Reservoir	0.06	2′ 6″	1 : 2 : 5	12′ 9″	3′ 0″	6″	24″x24″	none
1912	Roland Park, Md.	Reservoir	0.34	2′ 0″	1 : 2½ : 5½	13′ 0″	2′ 8″	6″	20″x20″	18″
1907	Philadelphia, Pa. Torresdale	Filters	16.50	2′ 0″	1 : 3 : 5	13′ 2″	3′ 0″	6″	22″x22″	21″
1907	Lawrence, Mass.	Filters	0.74	3′ 0″	1 : 3 : 5	13′ 2″	2′ 9″	6″	22″x22″	20″
1908	Pittsburgh, Pa.	Filters	46.0	3′ 0″	1 : 3 : 5	13′ 2″	3′ 0″	6″	22″x22″	21″
1910	Pittsburgh, Pa.	Filters (extension)	10.0	2′ 3″	1 : 3 : 5	13′ 2″	3′ 0″	6″	20″ diam.	21″
1904	Philadelphia, Pa. Belmont	Filters	13.23	2′ 0″	1 : 3 : 5	13′ 5″	3′ 0″	6″	22″x22″	21″
1913*	Baltimore, Md.	Filtered water reservoir	2.78	1′ 0″ to 2′ 3″	1 : 2½ : 5	13′ 6″	3′ 0″	6″	18″x18″	21″
1912	Philadelphia, Pa. Queen Lane	F. w. res. under final filters	17.2	none	1 : 2½ : 5	13′ 6″	3′ 9″	10″	30″x30″	none
1902	Natick, Mass.	Reservoir	1.02	2′ 0″	1 : 2½ : 4½	13′ 6″	2′ 9″	6″	20″x20″	none
1912	Grand Rapids, Mich.	Filtered water reservoir	0.57	1′ 6″	1 : 2 : 4	13′ 10″	3′ 0″	6″	14″x14″	22″
1902	Philadelphia, Pa. Lower Roxborough.	Filters	2.69	2′ 0″	1 : 3 : 5	14′ 0″	3′ 0″	6″	22″x22″	21″
1902	Lower Roxborough.	Filtered water reservoir	0.70	2′ 0″	1 : 3 : 5	14′ 0″	3′ 0″	6″	22″x22″	21″
1903	Upper Roxborough.	Filters	5.58	2′ 0″	1 : 3 : 5	14′ 0″	3′ 0″	6″	22″x22″	21″
1903	Upper Roxborough.	Filtered water reservoir	1.74	2′ 0″	1 : 3 : 5	14′ 0″	3′ 0″	6″	22″x22″	21″
1904	Belmont	Filtered water reservoir	3.48	2′ 0″	1 : 3 : 5	14′ 0″	3′ 0″	6″	22″x22″	21″
1907	Torresdale	Filters	24.75	2′ 0″	1 : 3 : 5	14′ 0″	3′ 0″	6″	22″x22″	21″
1907	Torresdale	Filters (extension)	7.50	2′ 0″	1 : 3 : 5	14′ 0″	3′ 0″	6″	22″x22″	21″
1907	Torresdale	Filtered water reservoir	10.53	2′ 0″ to 2′ 7″	1 : 3 : 5	14′ 0″	3′ 0″	6″	22″x22″	21″
1902	Milford, Mass.	Filters	0.25	1′ 6″	1 : 2½ : 5 / 1 : 3 : 5	14′ 0″	3′ 0″	6″	24″x24″	18″
1909	Springfield, Mass.	Filtered water reservoir	2.12	2′ 0″	1 : 3.1 : 5.3	14′ 0″	2′ 9″	6″	24″x24″	18″
1908	Columbus, Ohio.	F. w. res. (part of)	1.63	2′ 4″	1 : 2½ : 5½	15′ 2″	3′ 2″	6″	20″x20″	23″
1905	Washington, D. C.	Filtered water reservoir	2.28	2′ 0″	1 : 3.1 : 5.3	15′ 6″	3′ 6″	6″	30″x30″	24½″
1905	Ashland, Wis.	Filters	0.50	2′ 0″	1 : 2½ : 5	15′ 9″	3′ 6″	6″	28″x23″	none
1908	Pittsburgh, Pa.	Filtered water reservoir	6.36	3′ 0″	1 : 3 : 5	15′ 9″	4′ 0″	6″	27″ diam.	26″
1896	Somersworth, N. H.	Filters	0.50	2′ 6″	1 : 2½ : 5	16′ 0″	4′ 0″	6″	34½″x34″	none
1913	Minneapolis, Minn.	Filtered water reservoir	7.65	2′ 0″	1 : 2 : 4	16′ 4″	3′ 6″	6″	20″x20″	24″
1913*	Montreal, P. Q.	Final filters	6.9	3′ 0″	1 : 2½ : 5	17′ 0″	4′ 3″	0″	24″x24″	24″

* Under construction.

were in place ready for the pouring of additional arches in the position shown within the dotted lines.

On Thursday, Oct. 16, the backfill against the barrel arch along the north side of the reservoir was practically completed and filling was begun upon the completed groined arches. This filling was continued during Friday and for several hours on Saturday morning, when the work was stopped by rain. The approximate outline of the earth filling on the groined arches is shown on the accompanying drawing.

The depth of this earth fill cannot be actually ascertained excepting where it stood along the north wall after the failure as shown in the accompanying photograph. Levels taken over this standing earth showed that opposite the point of failure the earth fill had been made to about the required depth and the evidence would indicate that this sloped off to the outer edge of the earth filling where the fill was probably from 6 to 12 in. in depth.

Saturday and Sunday there were heavy rains and on Monday morning, Oct. 20, when four men employed in the concrete gang of the contractor walked out on the earth filling the arches suddenly began to fall. The first failure was between groins 10 and 25, and the last groins to fall were numbers 15 and 48.

The possible causes of the failure of these arches were due to:

(1) Defective Design.
(2) Defective Workmanship or Concrete.
(3) Premature Removal of the Forms.
(4) Premature Loading with Earth.

Design

The barreled arch and side wall of the reservoirs were so designed that the line of pressure for the contemplated loading lies within the middle third of the arch and wall section, and the compressive stresses in the concrete are well within the allowable stresses for concrete. The barrel arch and side wall are almost identical in section with the barrel arch and side wall for the Filter Water Basins at the Roxborough Filtration Plants in Philadelphia, and are very similar to a number of other side walls and barreled arches used in similar construction.

The groined arches of the type being built in Baltimore have been used very extensively in the United States in the last 10 or 15 years for covering reservoirs and slow sand filters, and a study of the stresses under the contemplated conditions of loading show that the compressive stresses in the concrete are within the limits which can be allowed on concrete of the character used in

construction of the work. In the accompanying table compiled by John H. Gregory, who was called in as Consulting Engineer in connection with the failure of these arches, are given data regarding a large number of groined arches actually built or under construction throughout the United States and Canada.

A study of the design of the piers also shows that the compression in these piers were well within the allowable stresses for concrete used in similar construction.

Considering the results of the theoretical studies of the barreled arch and side wall, the groined arches and the piers, and also the large amount of similar work actually constructed in a great number of other places, cu.yd. of concrete made from this sand and gravel were used. Neither the sand nor the gravel is always free from dirt, but the impurities are of such character that they do not seem to interfere with the strengh of the concrete.

The concrete was mixed in a batch mixer and owing to the method of placing, by means of a chute from a tower, it was necessarily mixed very wet. In order to secure the proper shape to the groined arches inverted cones were used over the piers.

An examination of the arches which had fallen showed that the concrete at the crown was always of the required thickness shown on the plans. In several places, how-

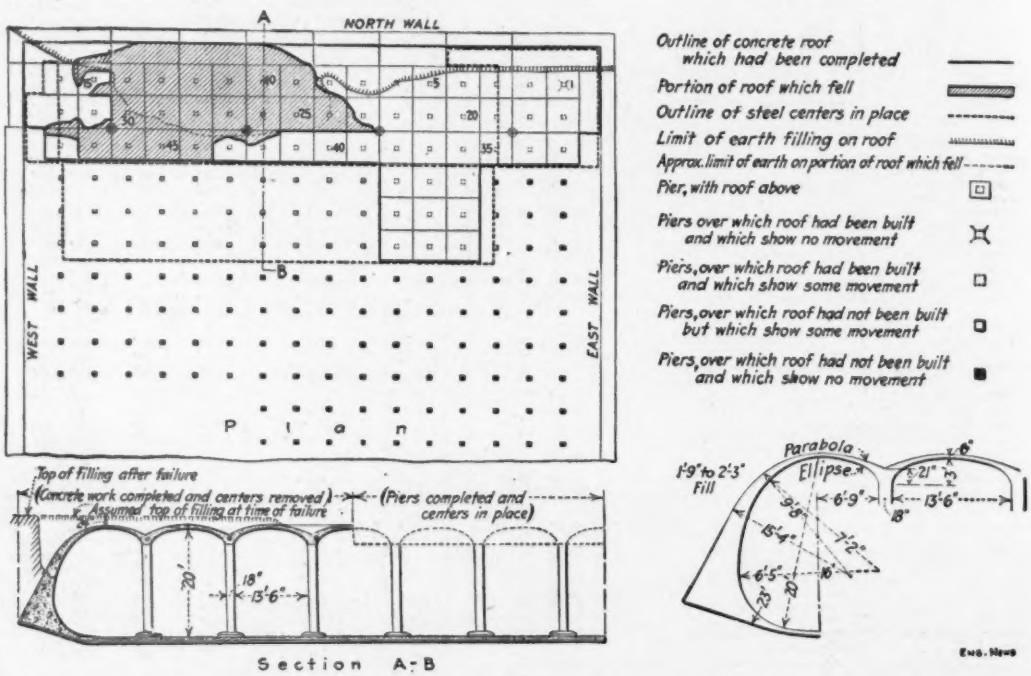


FIG. 1. LAYOUT OF GROINED-ARCH ROOF OF MONTEBELLO FILTERS, BALTIMORE, MD., SHOWING CONDITIONS PRIOR TO FAILURE OF OCT. 20, 1913

there is no room to doubt the safety of the design of the roof of the reservoirs in question.

DEFECTIVE WORKMANSHIP OR CONCRETE

A careful examination was made of the concrete and the materials from which the concrete was made. The cement used in the construction was manufactured by the Tidewater Portland Cement Co., of Union Bridge, Md., and every carload of cement used on the work had been sampled and tested at the Municipal Laboratory. Fifty-four of the fifty-five cars received passed both the 7-day and the 28-day tests, as specified by the American Society of Testing Materials, and one carload was held as the result of the 7-day test, but was passed on the results of the 28-day test. The cement was stored in a dry warehouse and well protected from the weather.

The sand and gravel used in the concrete was dredged from the waters in the neighborhood of Baltimore Harbor and is being used most extensively throughout the City for all classes of concrete work. The author had personal charge of the construction of the Sewerage Disposal Works for the City of Baltimore in which 60,000

ever, the concrete at the haunches, just above the inverted cones, was found to have settled slightly on the slope so that the haunches were not always of the required thickness. The reduction in thickness, however, was so slight that the failure could not be attributed to this cause, especially as the arches which failed first were of the required thickness.

The quality of the concrete throughout was good and in many instances the gravel in the aggregate was fractured where the concrete was broken at the time of the failure.

At only one point was there any evidence that the concrete was not of the best quality, but this point was nowhere near the first failure of the arches and the concrete was good and should certainly have withstood the compressive stress which it was designed to withstand.

Mr. Gregory in his reports states that, "From my examination of the concrete, not only that portion of the roof but in the portion still standing, and also from investigation of the conditions under which the work was built, I am of the opinion that the failure was not due to poor concrete."

Premature Removal of Forms

The first centers under the barreled arch along the north wall of the reservoirs was struck on September 16, fourteen days after the placing of the concrete in the arch and 34 days prior to the failure of the roof. The striking of the centers under the groined arches began on Sept. 25, and the construction records show that the concrete had been placed from about 19 to 46 days before the centers were struck. The first two groins to give away were groins numbers 26 and 10, and the concrete had been placed in groin number 26 about 20 days and in groin number 10 about 40 days prior to the striking of the centers. It is therefore evident that the failure cannot be ascribed to the premature striking of the centers.

Figs. 2-6. Views of the Montebello Filter after Collapse of Roof

Fig. 2. Looking West Toward Groins 15, 31 and 48. Fig. 3. Looking East Along North Wall.
Fig. 4. Looking North Across North Wall. Fig. 5. Looking West over Groins 5 to 8 toward Groins 15 and 31. Fig. 6. Looking East; Piers 42, 41, etc., on right.

Premature Loading with Earth

The analyses of the thrust produced in the barrel arch by the loading with earth shows that this thrust amounted to over 2000 lb. per lin.ft. of the wall. The loading of the groins themselves was also of such character as to tend to produce a thrust away from the wall and toward the outer side of the completed section, the earth filling being thickest toward the wall and falling off toward the outer edge of the filling. The effect of this unbalanced thrust was to push the groins and the columns in a southerly direction. The moments of stability against overturning by the three piers was not sufficient to balance the overturning moment of the thrust due to the earth loading on the barreled arches and the arches themselves. The movement in a southerly direction of the entire roof structure covered by earth and the adjacent structure still standing is clearly shown by the fact that all the columns left standing were tilted in a southerly direction, opening a crack at the base of the columns on the north side of the piers.

It is believed that the unbalanced thrust due to the earth loading caused sufficient movement in a southerly direction to separate groins 10 and 26 at the crown, thereby causing these groins to cease to act as arches and to act as cantilevers. The earth loading on these groins acting as cantilevers produced a tension on the upper side of the concrete greater than the concrete was able to stand and these two groins failed and large sections dropped into the reservoir below. The fall of these groins started the adjoining piers and groins and they began to

fall like tenpins. The evidence seemed to show that the time which elapsed between the fall of the first and last groins was between one-half minute and one minute.

As stated before, John H. Gregory, of New York, was called in as Consulting Engineer to investigate the causes of the failure and to pass upon the adequacy of the design of the groined arches. After a most thorough and exhaustive study of the situation, Mr. Gregory has submitted avery comprehensive report upon this failure, the results of which are summarized in the following paragraphs.

(1) That the groined arches were well and carefully designed and if built of the materials and in accordance with the requirements specified are safe and suitable for the purpose for which they were designed.

(2) That the design of the groined arches is in accord with what may be said to be practically standard practice in this class of work and is similar to that adopted in a large number of works already built and in service in the United States, among which may be mentioned those in Albany, N. Y.; Columbus, Ohio; Grand Rapids, Mich., Minneapolis, Minn., New Orleans, La.; Philadelphia, Penn.; Pittsburgh, Penn; Providence, R. I.; Roland Park, Md.; Springfield, Mass., and Washington, D. C.

(3) That no changes in the design of the groined arches be made and that the work be constructed as originally contemplated.

(4) That the failure was due to the premature loading of the barrel arches and groined arches with earth before provision had been made for taking up the thrust produced in the same by the earth loading.

Failure of Part of Lyman-Stark Bldg., Cedar Rapids, Iowa

On Nov. 14, 1913, at 3:30 p.m., the two rear bays of the entire three-bay width of the Lyman-Stark reinforced-concrete building at Cedar Rapids, Iowa, collapsed while a number of workmen were engaged on the construction. The falling mass carried down with it about a dozen workmen, seven of whom were killed. A Coroner's inquest is now in progress looking into the design and construction of the building and a number of experts have been called to testify as to the details of the building. Until this inquiry is completed, a complete analysis of the failure is not in order, but we give below a brief statement of the facts now available, prepared by Prof. B. J. Lambert, of the State University of Iowa, Iowa City, and obtained from other sources.

Prof. Lambert's Report

The building which failed is known as the Stark-Lyman block, and is to be used as a wholesale millinery establishment. The preliminary layout and plans were drawn by H. J. Bishop, an engineer of wide experience. These plans were submitted to the Wm. B. Hough Co., of Chicago, who completely designed and laid out the floors and columns, and resubmitted same to Mr. Bishop. After several revisions the plans were finally accepted and contract was let to Wasson & Lauritzen, of Waterloo, Iowa. Subsequent to the letting of the contract, the owners together with Mr. Bishop, their engineer, decided to have the plans rechecked, and for this purpose employed Ernest McCullough, of Chicago, well known as an authority in reinforced-concrete design.

The building is built of reinforced concrete with tile and concrete floors and covers a lot 60x140 ft. with panels 20x20 ft. in plan, there being seven panels one way and three the other. It is seven stories high, the 2nd to 7th story being 12 ft. each in clear and the roof about 95 ft. above street level. The floor girders run transversely, and the floor panels are built on the one-way reinforcement hollow-tile and concrete-beam system.

All floors above the first are constructed of 7x12x12-in. hollow-tile on 16-in. centers. This provides for a 4-in. concrete beam between tiles, which, with 2 in. of concrete covering specified makes a T-beam with 4x7-in. web and 2x16-in. flange. The steel consists of two ½-

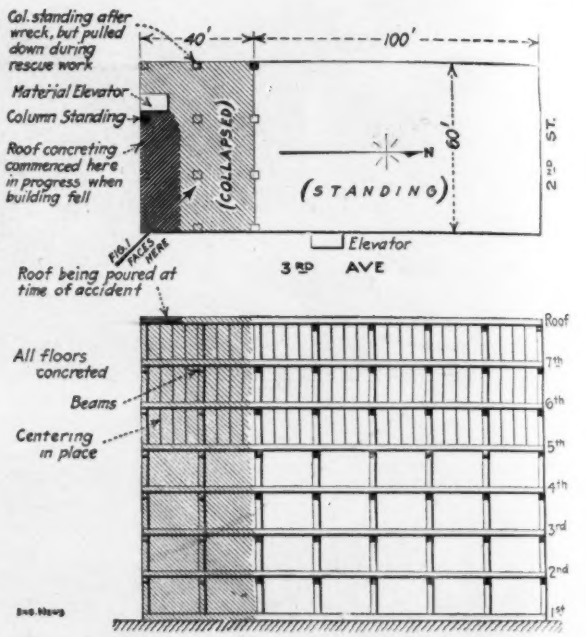


Fig. 1. Plan and Elevation of Reinforced-Concrete Building, Cedar Rapids, Showing Portion Which Collapsed Nov. 14

in. twisted rods and ¼-in. twisted rods transversely on 18-in. centers, characterized as temperature bars. With the exception of certain special columns the original plans called for 12x12-in. column in upper story with an increase of 2 in. each way per floor. As built, the columns are round, but compared with the square as specified are said to be of more than equivalent section.

The live load specified for the 2nd to 7th floors is 95 lb. per sq.ft., which would indicate that the Wm. B. Hough Co. used unit stresses in the steel and concrete approximating 20,000 lb. and 800 lb. respectively with a bending moment of $\frac{wl^2}{10}$. In the transverse beams which are 12x25 in. in full section the stresses will run still higher under full live load.

By reference to the view shown herewith, it will be noticed that the contractor has left the forms under the 6th and 7th floors and that the roof forms were practically half placed. At the time of the accident workmen were engaged in pouring the roof and had practically completed the work over the six panels that fell.

It will also be noticed that the columns have been stripped in all except the 7th story. The 6th floor columns together with the 7th floor slabs had been poured probably 8 to 10 days. The engineer reports that the lowest temperature at any time during the actual placing of the concrete was about 43°, that the colder weather of the past few weeks occurred while the forms were being placed. On several occasions the temperature has gone to 12° to 16° above zero and remained below the freezing point practically all day.

All kinds of theories are afloat as to the cause of the failure. One report is that the building was founded on quicksand, when, as a matter of fact, it is founded on solid rock over the entire lot, the average rock excavation for the cellar being about 3 ft. and running into very dense compact limestone. Another report is that the cement was not good and the concrete of inferior quality. The cement was of a standard brand, was frequently tested, and found uniformly good. The concrete was a 1:2:4 mix and the broken fragments present an unusually good appearance. Another report condemns the floor forms as being too weak, yet the same style of forms had held the lower floors which were somewhat heavier than the roof slab.

The most reasonable assumption seems to be that the failure started in an interior column due to overload on a green concrete from which the forms had been prematurely removed.

Additional Information

In addition to the above report we have obtained from various sources the following supplementary information. The engineer for the owners, H. J. Bishop, in 1908-09, was general superintendent of construction for the plant (with reinforced-concrete buildings) of the Corn Products Co., at Argo, Ill.* He laid out the plans for the Stark-Lyman building, and had architectural drawings made by Mayberry & Co., architects, of Cedar Rapids, Iowa. Acting for the owner, he purchased the reinforcing steel from the Wm. B. Hough Co., of Chicago, and this company prepared the structural design for the reinforced concrete, which was approved by the engineer. This design was made under the following specifications:

Tension in steel, 20,000 lb. per sq.in.
Bending compression in concrete, 750 lb. per sq.in.
Direct column stress on concrete, 660 lb. per sq.in.
Ratio of deformation was not stated, but calculations show that a ratio of 12 was probably used.
Column design was in accordance with Considere's formula.
Bending movement, W L ÷ 12 in center of span and W L ÷ 10 over the supports. All span lengths used were to be clear spans.

In June, 1913, before work was commenced, the contractors sent the plans to Ernest McCullough, consulting engineer, of Chicago, with instructions to check them to see if the specifications had been followed by the designers and "if the specifications have not been complied with whether the building will carry the loads according to the usual way such buildings are designed." His report was to the effect that the design throughout was consistent and that the drawings were satisfactory. Mr. McCullough informs us that while the allowed stresses were higher than he uses in his own practice they are sanctioned by the building ordinances of several cities (St. Louis among them). He states also that the drawings and details and the amount of steel used over the supports all showed designing work of a character better than that found in the average commercial design.

As stated above, the steel was furnished by the owner, the contractor furnishing all other material and labor. The centering and forms were all designed by the engineer, Mr. Bishop. On the 5th floor, which at the time of the failure was the lowest floor with centering in place, the centering consisted of posts spaced 4 ft. c. to c. with

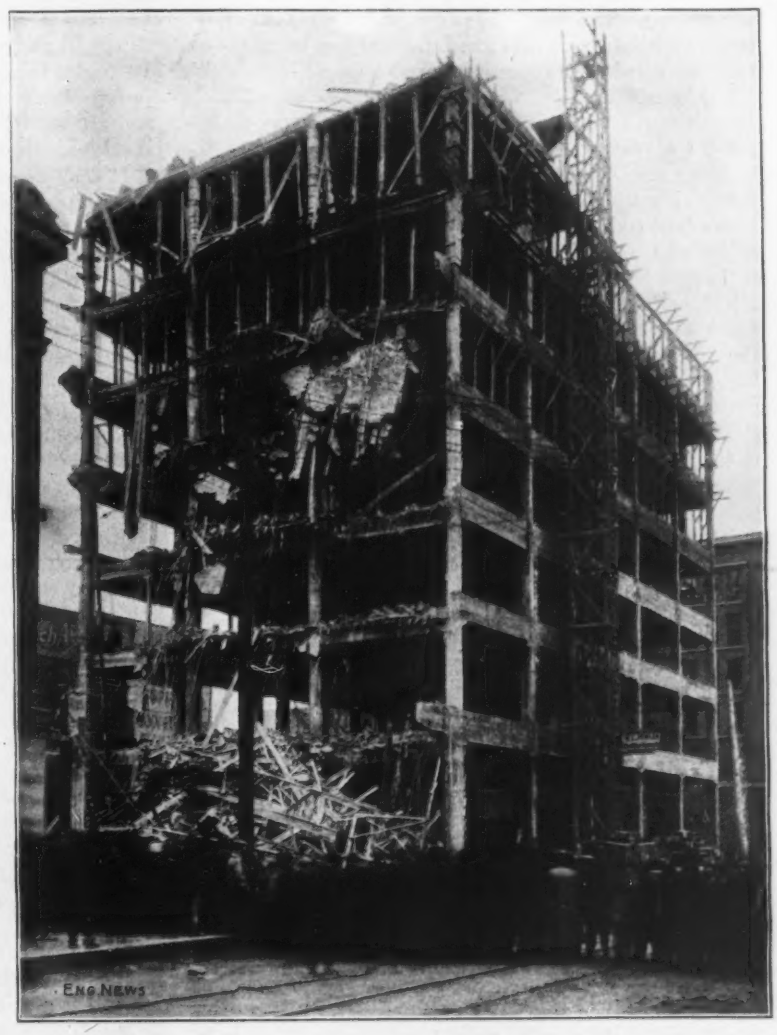


Fig. 2. View of Lyman-Stark Building, Looking Northwest Toward the Collapsed Portion

*"Engineering News," Aug. 26, 1909.

no diagonal bracing. No planking was used to distribute the load on the floor, but each post rested on a block 8x24 in. on the concrete over the tile on the floor and not on the concrete beams.

It is the opinion of some engineers who have examined the building that the failure may be accounted for by the disposition of this centering, combined with green concrete resulting from too rapid work during October and November, when the concrete above the fourth floor was poured. The 5th floor was poured Oct. 3; 6th floor, Oct. 14; 7th floor, Nov. 1; and the roof was being poured at the time of the failure on Nov. 14 (see Fig. 1). We are informed that on Nov. 20 the concrete on all floors above the 4th was still green looking. This was characteristic of the concrete in the wrecked portion of the building but the pieces in this wreckage could not be positively identified as to location. The view in Fig. 2 shows how completely the concrete stripped from the reinforcing bars. On the basis of the facts just presented it is thought by some that the main collapse occurred at the 5th floor, which carried the centering and load of the floors above and which was itself unsupported, though the concrete was fairly green and the centering loads highly concentrated.

Concreting was being done at the southeast corner of the roof starting at the rear end wall and not extending to the first row of beams and columns. Some of the evidence indicates that this weight of concrete, supported only by the wall and the centering, caused the wall to tilt outward (at the 7th floor) and drop the roof load upon the green concrete floor below. Adjacent to this section of the concrete roof was a material elevator which might have caused jarring and vibration.

The city is to make a test of the load capacity of the forward 100 ft. of the building which is still standing apparently uninjured. Meanwhile, it is necessary to await the complete presentation of evidence both as to design and construction before making any definite deductions.

The Washington Meeting of the National Conservation Congress

The National Conservation Congress, held in Washington last week, was one of the most tumultuous and exciting conventions ever held by a technical society. The Congress was attended by over 800 registered delegates representing every State in the Union. The program, as announced beforehand, contemplated forestry as the principal theme of this year's Congress. Instead of this, however, the question of water-power control forced itself to the front on the first day of the Congress and precipitated a bitter parliamentary battle between those representing opposing views, and from that time on practically absorbed the entire energy and interest of the delegates.

What brought on the fight was the several reports of the Committee on Water Power. This committee, which has been at work during the past year, was made up of Dr. George F. Swain (President of the American Society of Civil Engineers) Chairman, and Messrs. Gifford Pinchot, Henry L. Stimson (late Secretary of War), Lewis B. Stillwell (Past-President of the American Institute of Electrical Engineers), Chas. R. Van Hise (President of Wisconsin University), M. O. Leighton (late Chief Hydrographer of the United States Geological Survey), G. S. Webster (of the firm of Stone & Webster), B. M. Hall, of Atlanta, Ga., and Joseph N. Teal, of Portland, Ore.

It will be recognized that this committee represented not only technical experts of the highest standing, but very divergent and opposing ideas, so widely divergent in fact that to expect agreement on all vital points was recognized to be hopeless. Through the efforts, we believe, of some of the engineer members of the committee, it was arranged to draft a report which could be signed by the entire committee, stating such principles as all could agree upon. Supplementing this was a majority report signed by six members of the committee, and a minority report signed by Messrs. Gifford Pinchot, Henry L. Stimson and Joseph N. Teal.

It may be said at once, however, that none of these three reports went to the root of the matter which was agitating the delegates and on which the real fight of the convention was waged. This was the question: Whether the Federal government or the State should control water power. From all indications it appeared that delegations to the convention from most of the States west of the Rocky Mountains and from four or five of the Southern States came to the convention for the especial purpose of making a fight for exclusive State control; and interest in this special matter was so great that practically all other features touched upon in the committee's report were hardly discussed.

The whole day on Wednesday was spent in long and exciting debates, and in untying the parliamentary tangles which constantly occurred and which would have swamped the convention hopelessly had it not been for the remarkable tact and skill of the presiding officer of the day, Ex-Secretary Walter L. Fisher.

When a vote on the question was finally taken, each state voting separately, in accordance with the constitution of the Congress, the final result showed with between 500 and 600 votes cast there was a majority of over three to one against State control.

Near the end of the closing session on the following day, after many of the delegates had departed, the fight was suddenly renewed and was waged with great intensity for nearly three hours, when a final concluding vote showed about the same majority as the vote of the day previous.

As the so called unanimous report of the Committee on Water Power is a document of considerable importance it is reprinted below as follows:

To the Fifth National Conservation Congress:

The Committe on Water Power, while finding a difference of opinion among its members as to certain details of the subject feels very strongly the importance of making clear the general principles which control it and realizes keenly the consequences which would follow a failure to agree upon a constructive program of progress. It has, therefore, framed the following brief statement of the recommendations upon which it is unanimous.

A grant of the right to use a water power, while differing in some details is essentially similar to a grant of any other privilege or franchise from the Government, state or National, and its terms, regulation and control should be guided by essentially the same principles necessary to safeguard the rights of the public and of posterity as have been found essential in the case of other classes of franchises from the Government. Particularly is this true in view of the fact that a water power being perpetual will surely tend to increase in value as other sources of power, such as coal and oil, become exhausted. At the same time, for the very purpose of preserving our other power resources which are capable of exhaustion, the development of water power, under proper safeguards of the public interest should be earnestly

encouraged and hastened. We recommend that the following principles should govern the granting of a privilege to use a water power:

(a) For a definite period, sufficient to be financially attractive to investors, the privilege should be irrevocable except for cause, reviewable by the courts;

(b) Thereafter the privilege should continue subject to revocation in the absolute discretion of the Government exercised through its administrative board or officer upon giving reasonable notice and upon payment of the value of the physical property and improvements of the grantee as below provided under (h).

(c) After the expiration of the period provided for in (a) above, at recurring intervals of not more than ten years the amount of compensation to be paid to the Government for the privilege and all the terms and conditions of the grant during the next succeeding period of not more than ten years shall automatically come up for determination by the granting officer of the Government.

(d) The privilege shall be unassignable except with the approval of the Government in order to safeguard the interests of the Government against speculation in water powers and against appropriation without prompt development.

(e) The privilege shall be granted only on condition of development of the whole capacity of the power site as rapidly as the granting officer may from time to time require, giving due consideration to reasonable market demands and conditions and also on condition of continuous operation, subject to such demands and conditions.

(f) The right to receive compensation for the value of the privilege varying according to the proper conditions of each case shall be reserved to the Government, State or Federal, from whom the privilege comes. We believe that the reservation of such a right to compensation is a vital essential toward the end of proper regulation. It is not sufficient to trust that the public will always receive its proper share by means of regulation of rates alone. Local authorities may neglect or may be unable, under conflict of jurisdiction, or for other reasons, to exact in the interest of the public the full value of the public's right. The value of a water power may in the course of time increase far beyond the power of local regulation to adequately distribute its benefits. At the same time, the method of exacting compensation must be carefully safeguarded so that in case full compensation by rate regulation is exacted by local authorities, an additional burden shall not be imposed. We believe that in normal cases the best method is for the Government to share increasingly in the net profits of the enterprise, provided those profits exceed a certain reasonable percentage, the right of the Government being recognized otherwise merely by the imposition of a small annual fee or its equivalent.

(g) The Government shall have the right to prescribe uniform methods of accounting for the grantee and to inspect its books and records.

(h) Upon revocation of a privilege by the Government the grantee shall be paid a compensation equivalent to the fair valuation of its property, exclusive of franchise and consequential damages; this compensation shall include such appurtenances as are necessary for the operation of the water power and the transmission of electricity therefrom, but shall not include such properties as railroads, lighting systems, factories, etc., which are of themselves separate industries.

In such transfer all contracts for the sale or delivery of power made in good faith previous to such notice of transfer should be assumed by the transferee so that the said grantee may operate and maintain the power business during his occupancy of the property under such stable guarantees as may beget confidence therein by prospective long-term contractors, provided, that the Government or said transferee shall not assume any contracts made at a price or under conditions which shall be determined by the proper administrative officer of the Government to be unreasonable or confiscatory.

NOTES

A Slide of Rock, on Nov. 17, buried 300 ft. of double track, 60 ft. deep, near Ruby Creek, Man., on the main line of the Canadian Pacific Ry.

A Railroad Bridge Collapsed while under construction over the Ohio River at West Jefferson, Ohio, on Nov. 14, according to press dispatches. One man was killed and another was fatally injured.

A Coal-Mine Explosion occurred in Mine No. 2 of the Alabama Fuel & Iron Co., at Acton, Ala., at 3:45 p.m., on Nov. 18. Of the 43 miners entombed six were rescued, 24 bodies were recovered, and 13 were missing, on Nov. 19. Press dispatches state that the new Bureau of Mines hospital truck was dispatched to the mine, from Birmingham, Ala.

A Wooden Trestle Collapsed under the weight of a southbound passenger train on the Dardanelle & Ola R.R. (a subsidiary of the Rock Island Lines), 8 mi. east of Centerville, Ark., on Nov. 17, according to press dispatches. The engine and tender passed safely over the trestle, but the three cars following fell into a 12-ft. ditch, causing the injury of 15 persons and the death of one.

A Tunnel Under the Delaware River, connecting Philadelphia, Penn., and Camden, N. J., which was agitated several years ago, may become a fact. Charter rights for the construction of such a tunnel were issued on Nov. 22, at Harrisburg, to the Philadelphia Tunnel R.R. Co. The length of the tunnel, with approaches, is to be less than one mile, according to press dispatches. W. A. Stern, President of the company, stated that the work will commence in less than six months and should be finished within 18 months of that time.

Straightening the Grain Elevator of the Canadian Pacific Ry., at Transcona, Manitoba, which tilted to an angle of about 28°, as noted in our issue of Nov. 6 has been decided upon. According to a statement in the "Canadian Engineer," the Barnett-McQueen Co., which built the structure, proposes to excavate under the high side and allow the elevator to settle back to a vertical position. It will then be supported by jacking while the new foundation wall is built. Presumably the jacks will provide for restoring the structure to approximately its original elevation. This work is estimated to cost about $30,000.

A Garbage-Disposal Contract, to run ten years, has been made by the city of Los Angeles with C. C. Crouch, of Chicago. A reduction plant, which must be in operation in ten months, will be located on the river at Lenard St. The contractor will receive 51c. per ton for all garbage reduced, $3 for each dead draft animal, and 80c. for each calf, sheep, or hog, etc., but nothing for market rubbish and small animals. The city may otherwise take care of market rubbish, combustible refuse and all small animals, if it desires. The contractor must provide and maintain proper vehicles for removing dead animals and the city is to pay him all it collects under the ordinances for such service.

The city may purchase the plant after five years by paying the then value plus the earning value (estimated average annual profits capitalized at 6%). A minimum wage for employees of $2 is imposed and an 8-hour day, except in emergencies. After three days' continuous failure to dispose of the refuse, the city may take possession and run the works until it can make other arrangements for disposal.

PERSONALS

Mr. R. A. Dillon has resigned as Superintendent of Streets and Sewers of Cairo, Ill., to return to his former position with the Cairo Electric & Traction Co.

Mr. Frank McManamy, former Assistant Chief Inspector of locomotive boilers, Interstate Commerce Commission, has been appointed Chief Inspector to succeed the late John F. Ensign.

Mr. Heinrich J. K. Freyn, M. Am. Soc. M. E., formerly Consulting Engineer, Allis-Chalmers Co., Milwaukee, Wis., has been elected Third Vice-President of the H. Coppers Co., Chicago, Ill.

Mr. M. B. Morgan, recently Roadmaster of the Illinois Central R.R., at Fulton, Ky., has been promoted to be Assistant Engineer of Maintenance-of-way at Chicago, Ill., succeeding Mr. D. W. Thrower, promoted, as noted in our issue of last week.

Mr. C. Ewald Grunsky, Jr., M. Am. Inst. M. E., recently Superintendent of the Standard Consolidated Mining Co., Bodie, Calif., has become associated with the American Engineering Corporation, 57 Post St., San Francisco, Calif., of which his father, Mr. C. E. Grunsky, M. Am. Soc. C. E., is President.

Mr. Otto Wartenweiler, recently in charge of the construction of the new 400-ton milling and cyaniding plant of the

Commonwealth Mining & Milling Co., Pearce, Ariz., has organized the firm of Otto Wartenweiler & Co., Engineers and Contractors, Van Nuys Bldg., Los Angeles, Calif. Mr. Wartenweiler is Manager of the firm.

Mr. Morrel Vrooman, Assoc. M. Am. Soc. C. E., for a number of years head of the engineering department of the city of Gloversville, N. Y.; and Consulting Engineer on sewerage and water-supply, has resigned as City Engineer and will hereafter devote his entire time to the firm of Vrooman & Perry, Consulting Civil Engineers and Sanitary Experts, Gloversville and Amsterdam, N. Y.

Mr. Walter H. Flood, recently Chief Chemist of Chicago, Ill., municipal asphalt plant, and Engineering Chemist of the Bureau of Engineering of the city, has opened a consulting laboratory at 326 River St, Chicago, for the general practice of chemical engineering. Mr. Flood was formerly Chemical Engineer of the Holland Gelatine Works, Holland, Mich., and his new work will include besides the testing and inspection of road and other engineering materials the analysis of food and food products.

Mr. George E. Willcomb, Assoc. M. Am. Soc. C. E., Chemist in charge of the Albany, N. Y., water-filtration works, has become associated with the firm of Vrooman & Perry, Consulting Civil Engineers and Sanitary Experts, Gloversville and Amsterdam, N. Y. Mr. Willcomb is a graduate of the Massachusetts Institute of Technology and has had experience as Assistant Engineer with Hazen & Whipple, New York City, as a member of the staff of the sewage-experiment station at Columbus, Ohio, and a Chemist in charge of the water-filtration works at Watertown, and Albany, N. Y.

Mr. Walter E. Emery, for the past five years Chief Engineer of the Peoria & Pekin Union Ry., has been appointed County Superintendent of Highways of Peoria County, Ill., under the new highway law. Mr. Emery was the only one of four candidates successful in passing the required civil-service examination. Born in Calcutta, India, in 1863, and educated at the Government Civil Engineering College there, Mr. Emery has had a variety of engineering experience on five continents. For a time he was in the Indian railway service, going from there to Queensland, Australia; thence to South America, where he was Division Engineer on construction of the Transandine Ry., and of some Argentine railways. In 1891 and 1892 he was General Inspector on construction of the Cape Government Rys. in Orange Free State and Cape Colony, South Africa. From South Africa Mr. Emery came to the United States, where he served on the engineering staffs of various Middle Western railways. From 1896 to 1907 he was Roadmaster of the Chicago & Northwestern Ry., at West Chicago, Ill. Later he was Engineer of Maintenance-of-way of the Chicago & Alton R.R. at Kansas City, Mo., and since 1908 has been Chief Engineer of the Peoria & Pekin Union Ry.

Mr. William C. Brown has tendered his resignation as President of the New York Central Lines to take effect Jan. 1, 1914. Mr. Brown has been in railway work continuously for 44 years, for the past five of which he has been President of the New York Central Lines. He is 60 years old and has passed through nearly every grade in the operating department of the railway service, from section hand, when a boy of 16 years, to President of a railway systems operating 3800 miles of track at 55 years. His first work was on the Chicago, Milwaukee & St. Paul Ry., where he was section hand, fireman and telegraph operator. He then served as train dispatcher on the Illinois Central R.R., the Chicago, Rock Island & Pacific Ry., and the Chicago, Burlington & Quincy R.R. He was promoted to be chief train dispatcher, Trainmaster, Assistant Superintendent and Superintendent of the Chicago, Burlington & Quincy R.R.; after serving this railway from 1890 to 1896 as General Manager of subsidiary lines, he was made General Manager of the entire system. In 1901 Mr. Brown became associated with the New York Central Lines as Vice-President and General Manager of the Lake Shore & Michigan Southern Ry. Later his jurisdiction was extended over the other New York Central Lines, and in 1909 he was elected to succeed Mr. W. H. Newman as President.

OBITUARY

John H. Marble, member of the Interstate Commerce Commission, died Nov. 21, at his home in Washington, D. C., from acute indigestion. He was born in Ashland, Neb., Feb. 26, 1869. He attended the University of Nebraska and for a time was engaged in newspaper work on the West Coast. He was admitted to the bar in 1903 and began the practice of law in San Francisco, Calif. He was made attorney in charge of the division of inquiry of the Interstate Commerce Commission in 1906, and in 1912 was made Secretary of the Commission. He was appointed Commissioner in March of this year.

Ernest Pontzen, Officer of the Legion of Honor, Chevalier and member of numerous orders and institutes of foreign countries, one of the two corresponding members of the American Society of Civil Engineers, elected in 1876, died in Paris, France, Oct. 13, 1913. He was born in Vienna, Austria, in 1838, and graduated as "élève externe" from the "Ecole des Ponts et Chausseés," the training school for the government engineers of France, about 1860. All through his life he took great interest in this school and was President of the Association of its foreign graduates when he died. Some 40 years ago he removed to Paris, married there, became a citizen of France, and thereafter was sent on many government engineering missions. He was an official representative of France at the Centennial Exposition in 1873 and the Columbian Exposition in 1893, and at the International Railway Congress at Berne in 1910. He served on many government engineering commissions in France and its colonies. He visited the United States three times, and he frequently entertained and aided American engineers visiting Paris. Of independent means, he nevertheless lived a life of continuing, useful work; and in this form of his activity he will long be remembered—genial gentleman that he was—by those who had the pleasure of meeting him. [From Clemens Herschel, M. Am. Soc. C. E., Consulting Engineer, New York City.]

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 1-2. Annual meeting in New York Secy., W. H. Reed, 154 Nassau St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 2-5. Annual meeting in New York. Secy., Calvin W. Rice, 29 W. 39th St., New York City.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.
Dec. 8-11. Annual meeting in New York. Secy., Percy H. Wilson, Land Title Bldg., Philadelphia, Penn.

SAND-LIME BRICK ASSOCIATION.
Dec. 9-10. Annual meeting at Harrisburg, Penn. Secy., W. E. Plummer, Jr., 211 Fillmore Ave., Buffalo, N. Y.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Dec. 9-12. Annual convention at Philadelphia, Penn. Secy., W. H. Tolman, 29 W. 39th St., New York City.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Dec. 10-13. Annual meeting in New York. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Dec. 11-12. General meeting in New York. Secy., D. H. Cox, 29 W. 39th St., New York City.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 29-31. Seventh annual convention at Chicago, Ill. Secy., I. W. Dickerson, Urbana, Ill.

MINING AND METALLURGICAL SOCIETY OF AMERICA.
Jan. 13. Annual meeting at New York City. Secy., W. R. Ingalls, 505 Pearl St., New York.

AMERICAN WOOD PRESERVERS' ASSOCIATION.
Jan. 20-22. Tenth annual convention at New Orleans, La. Secy., F. J. Angier, Timber Preservation Co., Baltimore, Md.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.
Feb. 12-14. Meeting at Chicago, Ill. Secy., J. P. Beck, 72 W. Adams St., Chicago, Ill.

American Institute of Architects—At the 47th annual convention to be held in New Orleans, at the Grunewald, Dec. 2-4, the following special committees will submit their reports: Conservation of Natural Resources; Delegates on Testing Material; Electrical Code and Fire Protection; Fire Protection; International Congress of Architects; Town Planning; Government Competitions; Quantity Surveying.

American Society of Mechanical Engineers—In connection with the annual meeting, to be held in New York, Dec. 2-5, there will be a Railway Session at 2 p.m., on Dec. 3, at which two papers will be presented; one on "Steel Frame Box Cars," by R. W. Burnett, General Master Car Builder (Canadian Pacific Ry.), and one on "Steel Underframe Box Cars," by G. W. Rink, Mechanical Engineer (Central R.R. of New Jersey). Mr. Burnett will outline some of the factors which are responsible for the development of the box car, and the practice of the Canadian Pacific Ry. as to repairs, etc., with particular attention to the methods of selecting and treating the lumber for the sheathing and lining. Mr. Rink, in his paper, presents several tables showing the practice of a number of railroads, regarding the dimensions of various parts of box cars. This is toward making it possible to select a standard design of box car